

Canterbury Regional Energy Strategy Project

A Preliminary Stage 1 Report on Energy Security Issues in Canterbury

**A Report for the Canterbury
Regional Energy Forum**

CANTERBURY REGIONAL ENERGY STRATEGY PROJECT

A Preliminary Stage 1 Report on Energy Security Issues in Canterbury



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Project Details

The Canterbury Regional Energy Strategy Project (CRESP) is an initiative sponsored by the Canterbury Regional Energy Forum, aimed at securing the future of energy supply in the Canterbury Region through the development of a new paradigm that will facilitate cooperation and collaboration among regional stakeholders.

The Canterbury Regional Energy Forum consists of the Canterbury Employers' Chamber of Commerce, CAENZ, Environment Canterbury (ECan), Transpower Ltd., Orion New Zealand Ltd. and Meridian Energy Ltd., in addition to invited representatives from the Christchurch City Council and the Canterbury District Health Board.

Following a series of regional energy seminars jointly facilitated by CAENZ and ECan in 2005 [5], the Forum Group identified regional infrastructure decisions as a key strategic target for improving the future of energy supply in the Canterbury Region. In particular, the Forum identified the requirement for a Regional Energy Strategy that would facilitate local input

into regulatory decision making processes and secure industry agreement and collaboration to achieve a desired set of outcomes and options that would ensure the security of energy supply to the Canterbury region for the future.

Central to the development of such a strategy is the need for development of effective communication mechanisms between regional stakeholders, so that information related to risks and vulnerabilities of the regional energy system can be communicated to all stakeholders in such a way that they can easily understand what is important and can use the information to make informed decisions, in the face of sometimes conflicting and competing public goals, corporate objectives and multiple responsibilities.

This Stage 1 report summarises a characterisation of the Canterbury regional energy system and preliminary work undertaken by the study team to examine current issues impacting on the regions future assurance of energy supply.

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Glossary

Adequacy of Supply	The ability of the electric systems to supply aggregate electrical demand and energy requirements of their customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.
CECC	Canterbury Employers' Chamber of Commerce
Constraint	A local limitation in the supply capacity of a network required to maintain grid security or power quality.
Canterbury Regional Energy Forum	Consisting of the Canterbury Employers' Chamber of Commerce, Environment Canterbury, Meridian Energy, New Zealand Centre for Advanced Engineering, Orion New Zealand and Transpower, in addition to invited representatives from the Canterbury District Health Board and the Christchurch City Council
Deterministic Standard	Deterministic standards are based on the average level of security required for typical geographical locations, load group sizes and customer types. For a given fault, a deterministic standard always delivers a known outcome.
Distribution Network	Sub-transmission networks operated by Lines Companies
DTI	United Kingdom Department of Trade & Industry
EC	Electricity Commission
ECan	Environment Canterbury or the Canterbury Regional Council
EEA Guidelines	Power Industry Guidelines developed by the Electricity Engineers Association of New Zealand
Energy Poverty	Household expenditure on energy exceeds 10% of household income
GHG	Green House Gas
Grid Investment Test (GIT)	Is an economic test undertaken to compare the costs and benefits of different network solutions. Its general form is prescribed by the EC.
Grid Reliability Standard (GRS)	Is used to provide a basis, in conjunction with the Grid Investment Test (GIT), for planning and development of the national transmission grid.
Interrupted N-1 Security	Is similar to 'N-1 Security' but following a single fault the power supply is interrupted for a short period of time whilst switching of the network takes place. The advantage of this type of security over the 'N security' case is that power can be restored in switching time as opposed to fault repair time. For an 11kV cable network, this is typically a 6-8 hour time saving for each fault.
Interrupted N-2 Security	Is similar to 'N-2 Security' but following a double fault the power supply is interrupted for a short period of time whilst switching of the network takes place. For a 66kV cable fault, this is typically a 5 day time saving on fault repair time.

Load Shedding	Intentional action that results in the reduction of firm customer load for reasons of maintaining the continuity of service of the bulk electric power supply system.
LGA	Local Government Act
MinZone	Represents the minimum level of hydro storage required at any time of year to ensure that given a low flow event from that point in time, demand can still be met when all available thermal plant are run to capacity.
N Security	Is a network architecture without any redundancy. A single fault or failure event (N) in the network will result in an outage to customers.
N-1 Security	Is a network architecture that includes redundancy for the failure of a single transmission system component
N-2 Security	Is a network architecture that includes redundancy for the failure of two transmission system components
N-g-1	Is a network architecture that includes redundancy for the failure of a single transmission system component and the outage of the largest single local generator
NES	National Environmental Standards for Air Quality
Optimised Deprival Valuation (ODV)	Is the regulated value of a network and provides a value basis for calculating prices within that network
Outage – Normal Definition	An ‘outage’ to customer connections is considered to have occurred if supply is disconnected for any duration, i.e. any noticeable complete loss of power to a customer connection
Outage – Regulatory Definition	Where the power must be off for more than one minute to constitute an ‘outage’.
Probabilistic Standard	Probabilistic standards are based on the probability of failure of specific assets against the value of lost load to customers at that location. However, they do not deliver a known outcome for a particular event.
RAPS	Regional Area Power Systems
RMA	Resource Management Act
RPS	Regional Policy Statement
SAIDI	“System Average Interruption Duration Index” - measures the average number of minutes per annum that a consumer is without electricity.
SAIFI	“System Average Interruption Frequency Index” - measures the average number of times per annum that a consumer is without electricity.
Security of Supply	The ability of the electric systems to withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements.
Standing Losses	Losses caused by the energizing of the transformer core, and do not vary according to the loading on the transformer. They are constant and occur 24 hours a day, 365 days a year.

Switching Time	The time it takes power to be restored via network open point changes in the event of a fault.
Total Cost of Outage (TCOO)	The total annual cost of outages to customers when implementing specific network architectures.
Value of Customer Reliability (VCR)	This is a term used by VENCORP (Victoria Authority in Australia) to describe the equivalent of VOLL + VOI in this report.
Value of Interruption (VOI)	This is the value that an average consumer places on an interruption to supply.
Value of Lost Load (VOLL)	This is the average value that an average consumer places on un-served load or unsupplied energy.

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EXECUTIVE SUMMARY

Canterbury is one of the fastest growing regions in New Zealand. To fuel this growth energy is used in many areas including transport, agriculture, the power industry, manufacturing, domestic usage and business. Regional growth puts pressure on the systems that supply the region's growing energy demands. Planning for the future security of energy supply is both a national and regional issue with individuals and local communities looking for planning solutions that provide good outcomes for both New Zealand and the local region. Local regions have local energy usage trends, and continued reliance on centralised planning is not seen as the only way forward. Many communities are asking for a more balanced approach between top down planning and local distributed options.

A new approach to planning that takes better account of regional opportunities, industry capacity and local needs, can focus on creating local opportunities and delivering an overall improved energy supply system. This project aims to develop and outline such a process.

Stage 1 of this analysis helped define the strategic objectives that might inform the planning process and also identified a number of core issues for further investigation and analysis. These core areas are grouped into either Regional, Industry or Local contexts.

Regional

- 1 The Canterbury region has a higher than average dependency on major transmission and supply system security:
- 2 Emerging environmental issues could impact future energy demand and future energy supply opportunities, e.g. water scarcity/competition, air quality/fuel substitution choices, lack of reticulated gas
- 3 The region has resource potential to achieve greater energy diversity and less import dependency, but their economic timing and delivery remain uncertain.
- 4 Growth in tourism, business services and export food processing have contributed to

a large growth in transport related costs and the energy import dependency. Future growth could be aligned with alternative energy supply options – e.g. bio-fuels and hybrid vehicles.

Industry

- 1 Supply chain risk can be reduced by aligning industry planning assumptions including common time period outlook, asset age risk, aligning different planning frameworks and acknowledging non-aligned incentives or asymmetric risks
- 2 The current market response framework encourages shorter planning and investment cycles that shifts reliability related risk to the consumer, increases timing/delivery risks for investors, and makes planning lead times difficult to determine.
- 3 Incremental investment is valid but should not compromise the opportunities for realising key strategic regional benefits;
 - Incorporating a wider risk and vulnerabilities assessment.
 - Understanding situations where investing too late is worse than too early.
 - Adopting rules or guidelines vs commercial drivers.

Local

- 1 South Island Reserve Energy Options should examine further:
 - Regional winter market reserves risks.
 - Benefits of economies of scale vs distributed solutions.
 - Low South Island thermal reserves – value of system diversity.
 - The vulnerabilities from not having N-G-1 in Canterbury.
- 2 There are opportunities for more integrated energy supply developments including irrigation/hydro developments, waste to energy projects (with carbon credits), further regional distributed generation, smart pricing/metering and fuel substitutions.
- 3 The Region has some potential longer term

strategic energy assets including on- and off-shore gas prospects and wind power. Future planning needs to account for these through, for example, provision for transmission corridors to release local opportunities.

Stage 1 of the project has identified the above areas of interest for further study as they all have implications that directly affect both national and regional planning. Further analysis of issues and comparisons between alternatives is required in order to further develop a new regional planning framework.

The work undertaken in Stage 1 has led to the identification of objectives for work in future project stages.

These objectives include:

- Establish clearer security of supply standards for both energy and transmission. Report and communicate South Island reserve margins as input to future industry planning.

- Determine regional adequacy requirements as inputs in support of regional planning submissions on proposed future transmission and generation investment – establishing a regional critical path analysis for key infrastructure and new energy investment options.
- Examine in more detail the potential for DG type investment within the region.
- Undertake more in-depth assessments of novel applications to meet future energy supply requirements, in particular the future role of smart metering systems and local fuel substitutes.

The aim of the objectives listed above is the development of a Regional Statement of Opportunities (RSOO) that will communicate the range of possibilities for regional energy investment. The RSOO is intended to be used in developing a framework for examining different investment options in a more regionally focussed energy security planning process.

1 INTRODUCTION

The Canterbury region is one of the fastest growing regions in the country. To propel this development, energy from various sources and types is utilised to power industry and agriculture, and support business, development and lifestyle.

Energy survey information (Figures 4 and 5) illustrates an overall trend of increasing (as the trend is nationally), rather than *stabilising* or *decreasing* energy use, and an increasing dependence on oil products. Our ever-increasing reliance on energy for both 'stationary' and 'mobility' purposes coincides at a time when consumers face significant future uncertainty in regards to the availability and likely future prices of some energy sources. These issues are well canvassed in the draft Government New Zealand Energy Strategy [1].

What is now clear is that energy and planning for our future energy infrastructure has become both a national and a local issue. Factors such as the electricity industry reforms of the last decade, a growing community reliance on high quality energy services and, increasingly, climate change and other environmental issues are all acting to bring a greater immediacy to thinking about how, at a local level, we are going to meet the future energy needs of our communities. This shift in focus is occurring at the same time as a growing policy emphasis towards sustainable development and associated actions; of which a vital component is addressing energy security and supply and demand issues within the framework of creating for the country and its regions, a sustainable energy system.

Increasingly, as evidenced by the Canterbury regional energy seminars held in late 2005 [2], individuals and communities are looking for solutions and opportunities to influence policy so as to mandate better outcomes. What the seminars demonstrated was that these issues will need to be dealt within the context of the Canterbury energy system - which has its own

unique attributes in terms of: energy use patterns, location issues, user issues (e.g. Service standards) and network issues - rather than continued reliance on a business-as-usual, 'top-down' planning framework.

These 'cross-roads' issues are now being reflected in regional communities requesting regional solutions that provide an appropriate balance between developing or maintaining macro energy infrastructure versus provision of smaller distributed and 'micro' solutions. There is now more evidence available both nationally [3] and internationally (e.g. [4] and [5]) to suggest that 'community energy', based on a mix of distributed technologies offers a serious alternative or supplement to our centralised energy system.

A competitive and affordable energy supply is a prerequisite to continued economic growth and improvements to social well-being. Assurance of energy supply is therefore about making better use of energy and managing our energy vulnerabilities. It is ultimately about sharing in the responsibility for creating the balance between multiple and at times competing goals and making informed decisions for the future. These issues continue to engender ongoing debate.

This project is intended to pick up that challenge. It has set out to take a different look at the energy equation and, by so doing, begin to answer the question - can we do better in meeting future regional energy needs? The Forum's objective is to achieve for the people of Canterbury an assured future supply of reliable and affordable energy sufficient to meet the community aspiration's for this and future generations.

In essence the project is about providing improved choices, working together to make informed decisions, and sharing in the responsibility for risk mitigation with regards to the total energy system and security of supply.

2 PROJECT OVERVIEW

The overall objective of the Canterbury Regional Energy Strategy Project is to achieve for the people of Canterbury, a secure supply of reliable and affordable energy by identifying regional infrastructure assurance priorities and offering a framework for regional collaboration.

In particular, it is intended to improve energy delivery to the region through:

- Articulating the critical energy issues for the Canterbury Region;
- Characterising the risks and vulnerabilities inherent in energy supply to the region;
- Critically investigating and demonstrating viable options to achieve the desired energy balance;
- Aligning the investment plans and decision making frameworks of the regional stakeholders; and,
- Achieving regional agreement on the effects of trade-offs to reach a balanced perspective that takes account of security, risk, economic opportunity and consumer preferences.

This analysis, it is intended, will provide broad based priorities for improving resilience and investment in the underpinning energy infrastructure for the region and, thus, establish a robust framework for future regulatory decision-making and industry agreement on preferred options. The cornerstone of this project is a collaborative framework amongst the different stakeholder groups that will allow an optimal solution for the region, within the broader objectives of the national energy strategy and individual enterprise investment criteria.

In undertaking the study, 3 stages to the project were identified:

Stage	Description	Commencement
1	Characterisation of the Regional Energy System	Aug-Nov 2006
2	Regional Opportunities Analysis & Road Map	2007

3 Community Consultation and Communication 2008

Stage 1 is concerned with the development of a consistent framework and methodology, both for the project itself, and for ongoing future regional policy development. Stage 2 is intended to focus on creating a resilient energy infrastructure acceptable to all stakeholders and, lastly, Stage 3 will focus on the community consultation and communication plans that are essential for realising potential opportunities whilst managing community expectations for an affordable and reliable energy supply.

The principle driving this process is the recognition that no single solution is correct and that community awareness and participation will lead to improved choices.

This report covers work undertaken as part of the Stage 1 study. Specifically, the scope of work undertaken during this stage set out to:

- Characterise the energy system in the Canterbury region, in particular, reviewing system characteristics, vulnerabilities, potential investment opportunities and other relevant issues;
- Investigate the broad parameters and protocols for a framework that would allow major regional stakeholders to collaboratively address critical issues to ensure the future security of energy supply in the region;
- Review, align and standardise key concepts, definitions and terminology used by key regional stakeholder to ensure more effective communication and collaboration.

In undertaking the work, emphasis was given to bringing together relevant information on the Canterbury regional energy system. Underpinning this objective was the recognition that a different structure for industry collaboration was required to allow better information flows and communication between stakeholders. In order to ensure a robust framework for analysis, the study team then undertook further analysis of the opportunities for energy investment in the region, and the

implications of current regulatory and industry processes for delivering future investment into the region.

In particular, when examining the electricity sector, it was recognised that participants in the electricity market face varying degrees of regulation, they operate to different strategic horizons and objectives, have diverse risk appetites and measure their performance (and are measured in turn) using different yardsticks.

Thus a 'Common Language' Lexicon was produced to align all these different factors to a standardised and consistent yardstick in order to facilitate communication, and provide a basis for collaboration, between market participants at the regional level.

Table 1 (over) outlines the criteria defining the framework for this Lexicon. Moving beyond this point of development to a more generalised methodology that embraces the entire energy supply chain will require a major effort. Appendix 1 provides an indication of the variation in some of the key criteria used by the regional stakeholders for the range of activities described in the report.

At the end of the day, any road map for the future must be based upon a sound foundation of data gathering, consultation, expert knowledge and decision support tools, which will allow the prioritising of future effort and benchmark comparisons with the other regions.

The methodologies adopted by the project team are intended to provide this sound foundation. Our aim for the project is that it should become a leading project that will become a model for other regions to follow.

Study Approach

In undertaking the work, the programme was divided into two work streams:

WS01 – Grid Connected Energy System

WS02 – Non-grid Connected Energy Systems

Given the immediacy of the issues facing Canterbury, and the upper South Island in particular, related to transmission investment

and upgrade of the grid to improve security of supply, overall emphasis in this initial stage of the study was given to the grid-connected energy system. The analysis of the electricity system is therefore more in-depth than for the other parts of the regional energy system.

Thus:

WS01 covers:

- Regional characterisation of the electricity supply system
- Level of service
- Security of supply
- Future generation opportunities
- Implications for Canterbury regional system planning

WS02 covers:

- Outline of the Canterbury regional energy system
- Stock take of Canterbury's energy use
- Energy resources, and
- Implications for future energy prices and security.

In this report we summarise the key findings from the analysis undertaken and offer a perspective on the critical issues facing the region. For the grid-connected energy system, the assessment was then extended to explore the various trade-offs that may be required to reach a balanced perspective on the current situation. The work undertaken on the wider regional energy system focussed instead on delineating future supply opportunities through the use of case studies.

It must be remembered that this study is very much a work-in-progress. The two work streams have simply begun the process of assessment and analysis that is critical to defining future energy needs and the way forward for the region.

Our high level analysis also looks at the ways in which we go about making energy investment decisions. The compendium of data and information gathered suggests that energy consumption within the region will continue to increase along with population and economic growth. We argue that a secure and affordable

3 REGIONAL DESCRIPTION

The Canterbury region comprises eleven local government districts: Kaikoura, Hurunui, Selwyn, Waimakariri, Christchurch City, Banks Peninsula (merging into Christchurch), Ashburton, Timaru, Mackenzie, Waimate and Waitaki. This is the region north of the Waitaki River, south of the Clarence River and extends from the Main Divide of the Southern Alps in the west to the east coast (Figure 1).

Regional Demographic Profile

The region has a population totalling 526,300 (in 2004), which comprises around 13% of the New Zealand population, as shown in Table 2. Based on a projected annual growth rate of between 0.6 and 1.0%, a population of 584,400 is expected by around 2026.

Typically, those who live within the region are older and less multi-ethnic than the New Zealand average. However, the percentage of the regional population that is of working age is very similar to the New Zealand average.

In addition, incomes in Canterbury are lower than that generally in New Zealand. This is without consideration to the expenditure side of the ledger, that is, purchasing parity consideration, as property prices and many other cost of living items are lower in Canterbury than in some other major population centres. It is important to note, however, that the greater Christchurch urban area comprises around 82% of the overall Canterbury region by population.

A critical factor for overall residential energy consumption considerations is that the average household size in Canterbury is approximately 2.5 persons, significantly below the national

average of 2.7, although this may reflect the age distribution of the region.

Population Growth Prospects

In its recently released report, the Greater Christchurch Urban Development Strategy Forum included some projections on population growth and household formation out to 2026 and 2041 [8].

The Strategy assumes a population growth of less than 1% per annum to 2026. Household formation is projected to grow faster at 1.3% per annum with the result that the number of inhabitants per house is expected to fall from the current 2.54 to 2.35 by 2026. In line with an aging population, the labour force is projected to grow by only 0.8% pa.

While no projections of regional economic growth were readily available at the time of the study, a suitable working basis for future projections would be that the Canterbury region as a whole, and the greater Christchurch area in particular, will grow at least as fast as the national average (3% per annum).

By virtue of the fact that the Auckland region is projected by Statistics New Zealand to have by far the fastest population growth out to 2026, then this region will almost certainly have the highest economic growth.

Regional Economic Profile

The Canterbury economy accounted for 14.6% of total economic activity in New Zealand in the year to March 2004.

In 2004	Canterbury Region	New Zealand
Males	234,525	1,822,986
Females	246,924	1,914,282
Total	481,446 (12.9%)	3,737,268
Change since 1996		118,974
% change since 1996		3.2%

Table 2: Population Summary – Canterbury and New Zealand [7]

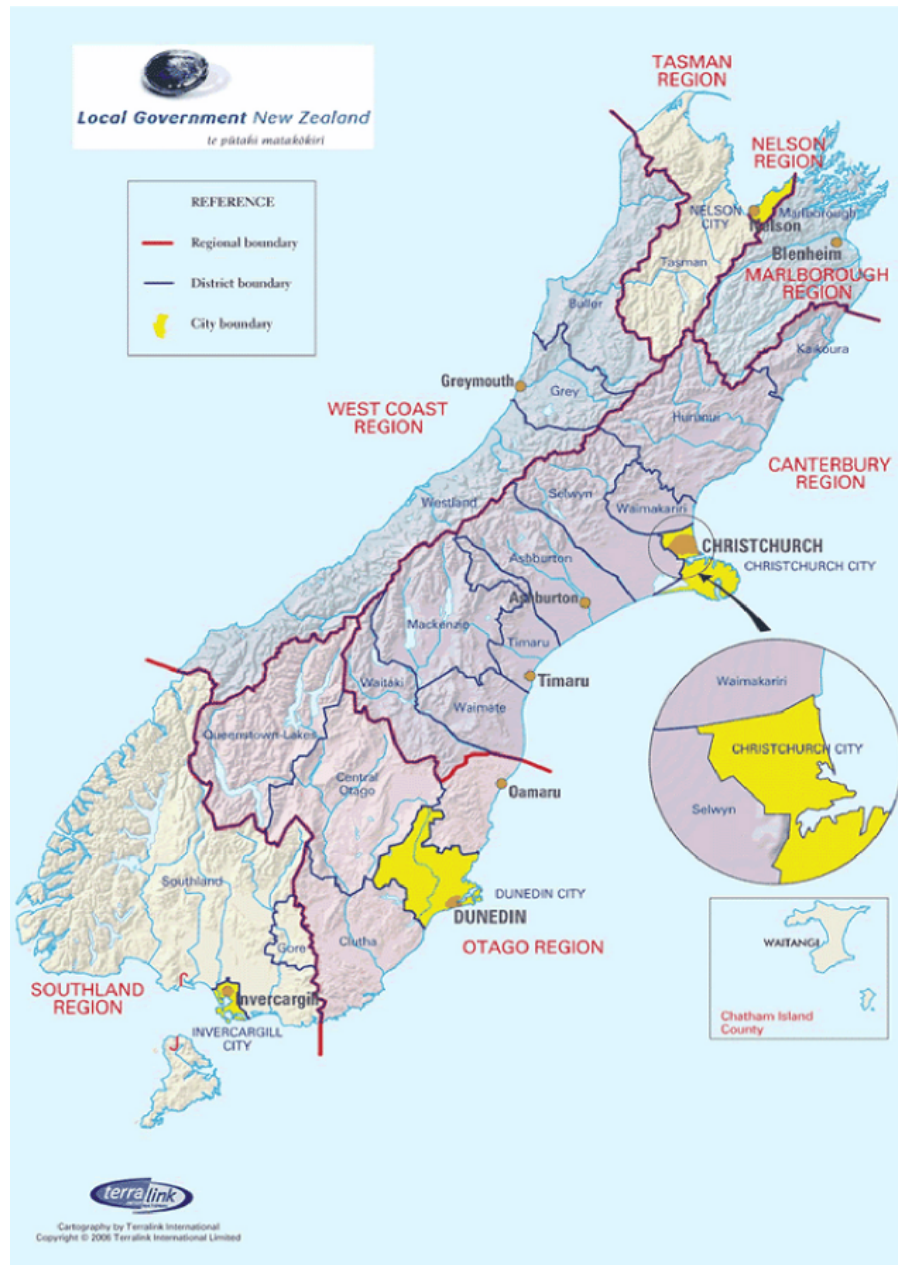


Figure 1: Map of the Canterbury Region [6]

Its regional GDP in the same year totalled \$19.9 billion, with a per capita nominal GDP of \$35,650 in the year to March 2003, compared to a national figure of \$32,100. Canterbury's per capita real GDP grew at an average of 3.7% between March 1998 and 2003, well above the New Zealand growth rate of 2.3%.

Canterbury's unemployment rate averaged 4.1% over the year to June 2004, compared to a national rate of 4.3%. The region's labour force participation rate is the highest in New Zealand, suggesting that the vast majority of able and willing workers are actively employed.

This is reflected in the relatively high GDP per capita in the region. It also indicates that any additional economic growth will have to stem from population growth or labour and capital productivity gains.

Labour productivity (real GDP per employee) in Canterbury grew at an average of 0.8% between 2000 and 2004. Nationwide, labour productivity growth averaged 0.9% per year over this period.

Canterbury spends an above-average amount on economic development relative to its GDP

(\$1,300 per \$million of GDP), compared to New Zealand as a whole (\$1,100 per \$million of GDP). Despite this expenditure, the region's enterprise creation and destruction rates are not vastly different to the national averages.

Economic Growth Prospects

Canterbury's economic growth between March 2000 and 2004 averaged 4.8%, compared to a national average of 3.5% for the same period, making Canterbury the second fastest growing region of those covered by NZIER's regional economic dataset.

The steady growth in the Canterbury economy of the past few years is, however, expected to slow in the near term. Current forecasts indicate that the South Island economy is cooling, with the annual rate of economic growth forecast to fall from 3.8% to 3.2%. Although this cooling trend is expected to continue for a few years, economic growth is still predicted, but at a slower rate than the past few years. In the Canterbury region, there has most recently been a decline in economic growth, with growth of 2.2% (quarter for quarter) in quarter 1 of this year, giving way to a 0.4% drop in quarter 2. This has been primarily attributed to the Canterbury economy's exposure to manufacturing and tourism, which are particularly vulnerable to recent high exchange rates and increased oil costs.

Industry Profile

The following diagram compares Canterbury's regional economic structure against the broader New Zealand economy. Plots to the right side of the dotted line (e.g. trade and tourism) indicate that the specified industry accounts for a greater proportion of the Canterbury GDP than it does at a national level; i.e. the industry is more 'important' to the Canterbury region than to the New Zealand economy as a whole.

Figure 2 suggests:

- A high reliance on various manufacturing sectors, relative to the national economy
- A relatively high dependence on faster-growing sectors (e.g. food, beverage, trade, tourism and other services)
- An under representation, relative to the New Zealand economy, in the business services, agriculture, natural resources and government sectors, which apart from business services, are all relatively slow-growing sectors at the national level.

Fast-growing regions tend to have a high proportion of their regional economies focused on fast-growing sectors, which may explain in part why the Canterbury economy has grown rapidly in recent years.

The Canterbury region should thus be seen as a vital contributor to the South Island economy

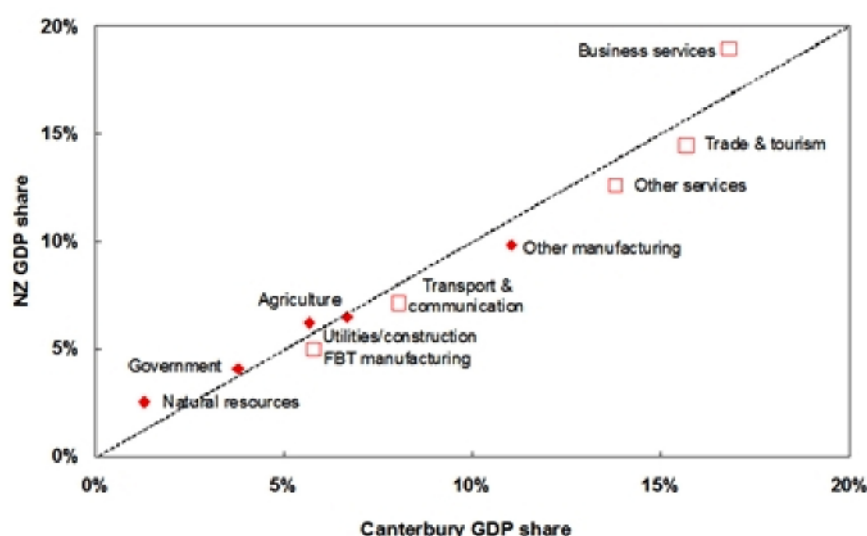


Figure 2: Canterbury's Industrial Profile [9] Key: the square scatter plots are industries that are fast-growing at a national level; the black diamond scatter plots are industries that are slow-growing at a national level.

and energy vulnerabilities within Canterbury will have potentially significant flow-on effects to the rest of the domestic and national economy. What is not obvious, however, from this preliminary analyses is the implications to the Canterbury economy of likely future changes to fuel pricing driven by national energy strategies and the regions high dependence on the food, manufacturing and tourism sectors.

As will become obvious in latter parts of this report, Canterbury is only selectively endowed with available energy sources; having limited new electricity generation potential, limited other regional energy production opportunities and a significant dependency on electricity for its core energy requirements.

An indication of this vulnerability is given by Figure 3 which tracks energy prices in the commercial sector over recent years. The largest increases have been in petrol and diesel although all commodities have had

significant price rises recently.

Consumers are generally price takers in the sense that they cannot influence the prices that they pay although they can influence their own technology choices and the amounts of energy they consume. Whilst some of the larger industrial and commercial users will have some influence on pricing due to their individual buying power and capacity to adjust energy use profiles, these opportunities too often are not realised because of a range of factors from institutional capabilities through to awareness of the demand side opportunities.

Because of the limited nature of this Stage 1 assessment, it has not been possible to address these issues in depth. One area for future investigation is to obtain a better understanding of those sectors likely to be vulnerable in the near to medium term due to pressures from increased demand on affordability and sustainability.

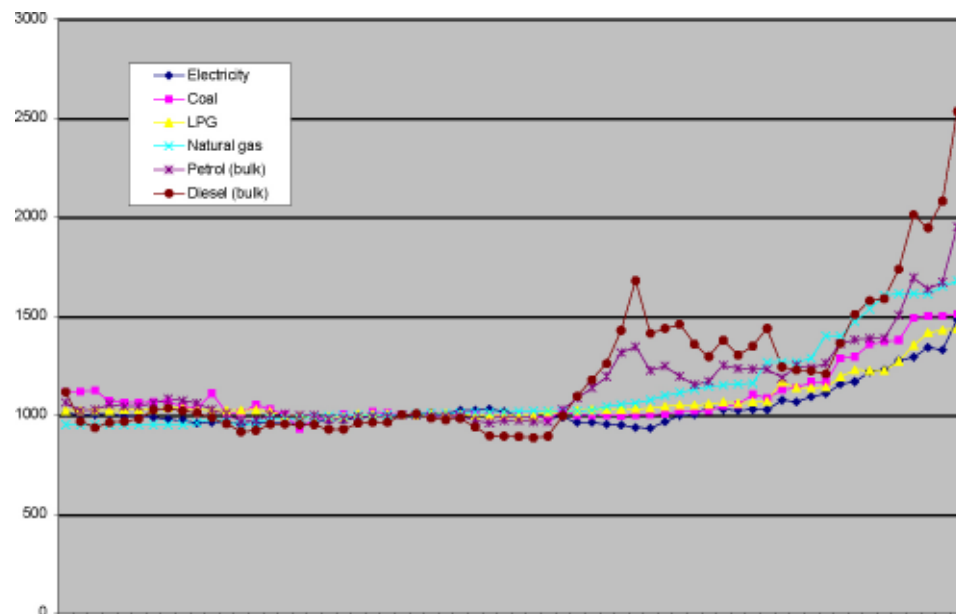


Figure 3: Energy Prices: Six-monthly, March and September 1991-2006, Commercial Sector (Stats NZ)

4 OUTLINE OF THE REGIONAL SITUATION

As previously discussed, energy consumption within the Canterbury region will continue to increase along with population and economic growth. This leads to issues of affordability and sustainability.

The region produces around 28% of New Zealand's electricity supply from Meridian Energy's stations in the Waitaki system. Around 50% of the (net) production is consumed within the region with the remaining 50% being exported.

However, the bigger picture also indicates that Canterbury, and the South Island in general, is becoming increasingly reliant on electricity deliveries from North Island thermal generation. In 2006, for the first time, the Minzone¹ was the South Island Minzone and not the New Zealand Minzone. This southward shift simply reflects the dry year risk to South Island generation.

Of current energy supply, the Canterbury region can at best be described as selectively endowed. The region does not have any hydro-carbon production aside from a small coalmine. All liquid fuels, gas and coal consumption, together comprising around 75% of total energy consumption, are imported, either from other regions within New Zealand or (originally) from overseas. In total, therefore, and taking into account the imported electricity compo-

nent, approximately 89% of the region's energy requirements are imported.

Environment Canterbury already conducts a biennial regional energy survey, the most recent of which was up to 2004 and published in May 2006 [6]. Table 3, Figure 4 and Figure 5 sourced from the ECan Survey summarises energy consumption by type and by sector, respectively.

The total energy consumed has almost doubled in 22 years with the biggest increases being in Wood and Oil Products consumption. Consumption by sector shows an increase of 3.59% in energy use for transport compared to an overall energy consumption increase of 2.88%.

These data highlight the importance of oil products (over 60% share as shown in Figure 5), almost all of which is consumed in the transport sector (around 57% of consumption in 2004) [6]. It is no surprise then that the greatest challenges to energy conservation and containment or reduction of greenhouse gas (GHG) emissions pertain to petrol and diesel consumption in the transport sector. Peer review notes that Stage 2 could address why there has been such a large increase in the use of transport fuels and investigate how carbon mitigation policies may affect various transport users and economic growth.

Also, anecdotally, we know that recent considerable price increases for transport fuels combined with increased electricity pricing and tougher environmental standards for home heating (in particular) has resulted in an increasing proportion of the community becoming "energy poor". Moving towards a "cleaner" energy future could well exacerbate this disparity unless appropriate policies are adopted to lessen the pricing impacts of alternative fuel choices. Peer review noted that examples of the disparities could be developed in Stage 2 to highlight and study possible problems.

¹ The Minzone is an analytical tool that is based on the record of 74 years of hydro inflows into the storage lakes and is intended to provide a 1 in 74 security of supply standard. As hydro storage levels drop due to lack of rainfall, the risk of shortage increases. If storage falls to the Minzone line, it means that from that point there is at least one annual inflow sequence out of the 74 on record which, if repeated, could result in empty reservoirs if no action is taken. When storage is at or below the Minzone, all thermal plants need to be running and all hydro generators need to be conserving water to the maximum extent possible. Whether a national or South Island

Minzone exists is established by identifying and comparing minimum national and minimum South Island storage levels from the simulations of supply and demand for each historic inflow sequence. If at any point in time, the simulated minimum national storage requirement is less than the minimum South Island requirement, a South Island

Minzone will exist, that is in the simulation, with all thermals operating to conserve hydro storage releases, simulated North Island storage will increase if transmission constraints prevent some North Island supply being transferred to the South Island. [10].

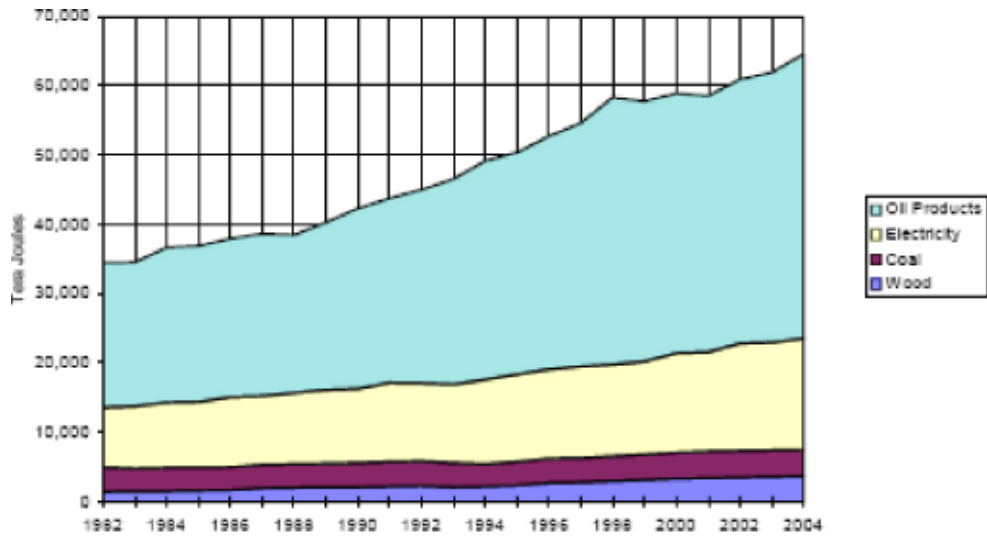


Figure 4: Canterbury Region Energy Consumption by Energy Type 1982-2004 [6]

	TJ	% of Total Consumption	Annualised % Growth
Oil Products	41058	63.83%	3.13%
Electricity	16040	24.94%	2.89%
Coal	3824	5.94%	0.32%
Wood	3405	5.29%	4.04%
Total	64327	100.00%	2.88%

Table 3: 2004 Canterbury Region Energy Consumption by Type and Growth Rates [6]

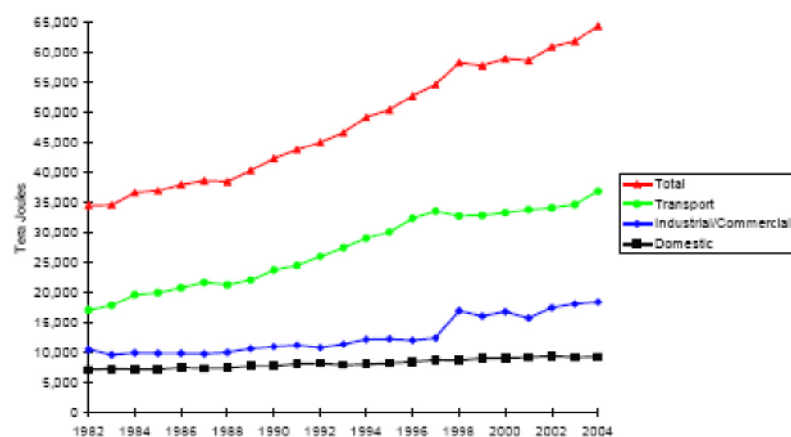


Figure 5: Canterbury Region Energy Consumption by Sector 1982-2004 [6]

5 BACKGROUND

Electricity

The electricity system in New Zealand is characterised by a long skinny high voltage transmission system that runs through the centre of the country.

The transmission grid is connected between the North and South Island by a 1200MW HVDC submarine cable link across the Cook Strait. Due to the geographical isolation of the country, there are no interconnections with other power systems.

Annual generation is approximately 41,000 GWh [33] and is dominated by hydro- power, although this has decreased from approximately 75% in the 1990's to around 60% of total generation today. Other types of generation include gas, coal, geothermal, wind and various small scale biomass and solar.

Transmission of power is very important as the geographical generation centre is at Benmore in the lower South Island but the geographical demand centre is in Hamilton. This discrepancy requires electricity to be transmitted long distances across the system.

Market Operation and Market Participants

The electricity industry in New Zealand has four main categories of market participation. These are: retail, distribution, transmission and generation.

The participants that compete in the market are the retail and generation companies. Transmission and distribution are considered to be natural monopolies and so operate their own networks within the regulations of electricity market. The wholesale market is the market in which generators compete to be dispatched and hence get paid by the market at the nodal price. Retailers and other purchasers such as major commercial and large industrial users buy electricity from the market at the nodal price. Every half hour each retailer submits a demand bid and each generator submits an offer of generation. The System

Operator takes the demand bids and while considering security implications and operational parameters, dispatches the lowest cost generation, to meet that demand, for that half hour.

The retail market is a market where electricity retailers compete for customers. Each retailer estimates their load and submits a demand bid to the system operator. At each network node, the purchases made by retailers from the wholesale pool are exactly matched to the physical demand uptake. Retailers can use financial instruments such as hedges to manage the risk of spot price variability but these are completely separate from the physical operation of the electricity system. External peer review has noted that further clarification and exposition of the difference between physical electricity supply and the financial instruments used to manage risk is required. This point is accepted and these issues will be considered in the next stage. The main issue being that there is no requirement within the financial hedge instrument to actually supply power, it can be a completely paper transaction.

There are various views on how the market achieves the overall objectives set out in the Electricity Act and Governance documents but these issues are beyond the scope of this project. There is, however, a close linkage between market price and investor confidence and some of these risk issues will be discussed in subsequent sections of the report.

Figure 6 provides an illustration of the New Zealand Electricity System in some aspects. It is included in this report for illustrative purposes, but reinforces the complexity of the institutional, market and regulatory arrangements, which ultimately govern industry investments. Obtaining an optimal solution within such a framework for the physical delivery of electricity at 'least cost' is thus fraught with difficulty. Peer review notes that the difficulty in obtaining an optimal solution is especially true due to market financial instruments not being directly related to physical

ENERGY MARKET STRUCTURE

RESOURCES

GENERATORS

SMALL/MED (DG/EG)

LARGE (BASE & PEAK)

CONSUMERS (METERS)

RETAILERS

MARKET* RETAIL/WHOLESALE/ FINANCIAL

TRANSMISSION OWNER/OPERATOR

DISTRIBUTORS NETWORKS

INDUSTRIAL RESIDENTIAL COMMERCIAL

TOWNS FARMS

URBAN

RURAL

CITY (COUNCIL)

TOWN (COUNCIL)

DISTRICT (COUNCIL)

REGION (COUNCIL)

ENVIRONMENT MFE, RC, MED

REGULATOR CC, EC, MED

LINKAGES:

- POWER FLOWS
- REGULATIONS
- \$\$\$ FLOW
- INFRASTRUCTURE

CONSTRAINTS TO BE ADDED

* Aggregate - no details

delivery. Further exploration of the security issues this 'disconnect' poses could be included in Stage 2.

Production

The chain of 8 hydro stations generates around 9,500 GWh (34,200 TJ) annually, depending mainly on inflows, and contributes a major portion of the generation in the South Island, feeding the 220 kV network from the Tekapo B, Ohau and Waitaki Valley generation stations

Embedded generation plant contributes a very small amount of generation to the region; approximately 3GWh (predominantly diesel and

Transmission and Grid Connections

Canterbury's transmission network comprises 220 kV and 66 kV transmission circuits with interconnecting transformers located at Bromley and Islington. There are four 220 kV transmission circuits supplying central Canterbury (Christchurch and surrounds), one from Tekapo B, one from Livingstone, and two from Twizel. These transmission circuits connect at either the Islington or Bromley substations. Supplying areas north of the Canterbury region are 3, 220kV circuits to Kikiwa. These lines originate at the Islington substation.

The South Canterbury region is supplied by 220 kV and 110 kV transmission circuits with interconnecting transformers at Timaru and Waitaki. The 110 kV network is normally

operated split at Studholme creating two radial feeds:

- Timaru 220/110 kV interconnecting transformer banks supplying Albury, Tekapo A and Temuka; and
- Waitaki 220/110 kV interconnecting transformer banks supplying Studholme and Oamaru.

This region contributes a major portion of the generation in the South Island, feeding the 220 kV network from the Tekapo B, Ohau and Waitaki Valley generation stations.

The North Canterbury area is considered by Transpower to be within the Canterbury region itself. This area operates mostly at the sub-transmission level, where Transpower owns the 66kV network.

Upgrades and Further Investments

Currently Transpower is assessing its options for further upgrade to the transmission network to meet identified constraints. They are working with the responses received after the Request For Information process that was undertaken in 2005/2006 including options for demand side management with a number of customers. An interim solution proposed is the bussing of existing 220kV transmission lines, from Waitaki to Christchurch, at Geraldine, which will effectively reduce the impact of a possible outage of a line.

Proposals are underway for submission to the EC on this project. In the meantime, a number of transmission projects have been commissioned in early 2006 including:

- A third 220 kV circuit between Islington and Kikiwa;
- 220 kV interconnection at Waipara and Culverden.
- A new 110kV GXP at Black Point.

Sub-transmission / Distribution Networks

The Canterbury and South Canterbury regions have five main areas of sub-transmission and distribution. Each of these areas is owned and operated by a separate company.

- Network Waitaki encompasses the areas of North Otago and the Hakataramea;

- Alpine Energy encompasses the region between the Rangitata and Waitaki rivers and inland to Mount Cook;
- Orion encompasses a large area including Christchurch city, Banks Peninsula, the Port of Lyttelton and the farming communities of the Canterbury plains between the Waimakariri and Rakaia rivers and the high country area inland to the main divide of the Southern Alps;
- Electricity Ashburton covers the region between the Rakaia river in the north and the Rangitata river to the south and from the coast to the main divide;
- MainPower operates the network in North Canterbury from north of the Christchurch urban region, inland to the Southern Alps and northward to Kaikoura. The Mainpower network also includes the Wigram area of Christchurch, supplied from the Orion network rather than a Mainpower substation.

Electricity Demand

Most networks within the Canterbury and South Canterbury region are experiencing annual energy (GWh) growth rates between 2 and 3% and peak demand growth rates of between 1% and 2%. Orion undertakes a lot of work on peak shifting its load, resulting in its peak demand growth rate being at the lower end (1.3% averaged over 20 years).

Projections made by the Electricity Commission [14] suggest that electricity demand growth in Canterbury (not including South Canterbury) will continue to be quite strong at around 2.32% per annum between 2005 and 2025; ahead of the national average of 2.09% per annum and well ahead of average South Island growth of 1.53% per annum and South Canterbury growth of only 1.21% per annum.

However, it is the view of the study team, that given the earlier economic predications and the lower forecast growth in household and industrial sectors the basis for these Electricity Commission estimates are open to scrutiny and may well be unduly optimistic. More investigation of these factors is warranted.

Other Supply

The Canterbury region, compared with many

other regions in New Zealand has a share of energy production options but many potential resources are largely untapped due to the affects of government policy initiatives. It appears likely that Canterbury will continue to have a heavy reliance on imported fuels, and in the future will remain a price taker with added cost from transport and distribution charges.

Oil and Gas

The Canterbury basin offers the most significant prospective opportunity for the region in regards to new energy production. Any oil and gas discovery would transform the energy supply picture and energy infrastructure of the region and thus we have included in Section 7 of this report a more detailed summary of the overall prospectivity of the basin. Values attributed to a probable commercial find in the basin are of the order of NZ\$1 billion.

Currently all consumer oil products are imported into the region. Table 4 sets out the relative amounts used for transport and non-

	2004 million litres
Transport	1077
Non-transport	143
Total	1220

Table 4: Liquid Fuels Consumption in Canterbury [6]

transport uses (Ref 18).

Four companies dominate petroleum distribution and retailing; BP, Mobil, Shell and Caltex. These companies have interests in the Marsden Point oil refinery and, between them, they own most of the bulk storage facilities and many of the country's petrol stations.

Petroleum fuels are predominantly shipped to Lyttleton Port from Marsden Point, with smaller amounts being shipped to Timaru. There are tank farms located at both of these ports that comprise the main bulk storage facilities. From Lyttleton Port, products destined for the Christchurch market are transported through a pipeline, owned by Mobil, over the Port Hills to

	Vehicle	Aviation	Marine	Rail	Total
	TJ	TJ	TJ	TJ	TJ
1982	13,910	1,550	1,077	409	16,946
1983	13,962	1,768	1,656	425	17,812
1984	14,456	2,038	2,695	396	19,585
1985	14,066	2,341	3,043	431	19,881
1986	14,478	2,768	3,041	409	20,696
1987	14,495	3,380	3,308	418	21,602
1988	14,575	3,538	2,699	391	21,202
1989	14,831	4,014	2,802	374	22,020
1990	15,330	4,300	3,667	370	23,667
1991	15,627	3,919	4,502	354	24,402
1992	16,503	4,061	5,025	397	25,987
1993	17,186	4,542	5,255	397	27,380
1994	18,042	4,689	5,719	532	28,981
1995	18,586	4,987	5,817	594	29,983
1996	19,264	5,404	6,958	649	32,274
1997	19,879	5,436	7,525	647	33,487
1998	20,015	6,019	5,970	660	32,663
1999	21,243	6,026	4,763	674	32,705
2000	21,857	5,997	4,674	687	33,215
2001	22,521	5,552	4,914	701	33,687
2002	23,465	5,216	4,678	711	34,069
2003	24,096	5,490	4,320	728	34,635
2004	25,133	6,548	4,412	709	36,801
(1983-2004)					
Mean Incr (%p.a)	2.70%	7.10%	8.40%	2.90%	3.60%

Table 5: Canterbury Transportation energy consumption by mode (TJ) [6]

Woolston. Product destined for elsewhere within the region or the West Coast is moved from the port by road transport.

Bulk storage facilities are capable of holding around 49.5 days of regional consumption in 2004 [6]. Timaru Port has around a quarter of the region's storage capacity and thus has much more capacity relative to local consumption than does the Christchurch region.

Table 5 shows the breakdown of transport energy fuels by mode. The greatest increases have been in marine (7.10%) and aviation (8.40%) with both having increases far greater than the total increase in transport energy consumption of 3.6%.

LPG

Liquefied petroleum gas (LPG) is the only available gaseous fuel (typically a combination of propane and butane) in the South Island. Table 6 shows the LPG storage facilities in the region. There are no storage facilities at Lyttelton. LPG is sent via pipeline over the Port Hills to the Liquigas storage site near the Woolston liquid fuels depot. Rockgas' and Ongas' storage facilities are adjacent. Peer review notes that no mention is made in the report of how LPG arrives in Canterbury. Identification and analysis of this import process could be made in Stage 2 of the project.

Annual consumption in the region in 2004 was estimated to have been around 50,000 tonnes. This suggests that available storage was around 10-11 days' consumption in 2004. With rapidly increasing consumption, this coverage is decreasing rapidly in the absence of some capacity expansion.

This (maximum) consumption coverage stands in contrast to the amount of coverage for other petroleum fuels.

Coal

Over 120 coalmines have operated in Canterbury since 1866, producing a total of about 2 mt [13]. It is estimated that slightly over half of the total economically recoverable resource remains. [13]. There is only one mine currently operating which produces around 2000 tonnes per annum, or roughly 0.05 PJ, for local use.

	Maximum Storage
	000 litres
Lyttelton Port	0
Woolston	2000
in Lyttelton-Woolston Pipeline	130
From Woolston	
- Rockgas Storage	
Rockgas Ltd	20
Underground Storage	500
Harewood	40
Ferry Rd	20
Bryon St	25
- Ongas	
Ongas Ltd	20
Tumara Park	20
Canterbury Spinner Ltf	20
Total	2795
Total (tonnes)	1500

Table 6: Gas (LPG) Storage in Canterbury [12]

Anecdotally, there appears little interest in further expansion of the industry within the region.

This is in contrast to the overall national picture, where domestic production, has increased from 52 PJ in 1980 to 137 PJ in 2004, an average increase of 4% pa since 1980. National consumption, however, has been fairly static during this period at around 50 PJ pa. That is until 2002, when Huntly gas/coal power station began generating extensively with coal, resulting in domestic consumption rising to 97 PJ in 2004, with the balance of production being exported, almost totally through Lyttelton Port. The Peer Review noted that while domestic production increased between 1980 and 2004, domestic consumption was flat. Identification of where the increased production went, e.g. export, would be useful.

Table 7 summarises coal consumption in Canterbury. Over the years, slowly increasing industrial/commercial consumption has been substantially counterbalanced by a rapid decline in household consumption where, in Christchurch, coal fires are now banned. Industrial consumption is dominated by Fonterra's Clandeboye dairy plant.

Export of West Coast coal through Lyttelton Harbour has significantly increased in recent times and now accounts for over 25 percent of the port's throughput volume. The West Coast

	Ind/Comm	Residential	Total
	TJ	TJ	TJ
1982	2,612	950	3,562
1983	2,530	756	3,286
1984	2,598	710	3,309
1985	2,667	665	3,332
1986	2,735	620	3,354
1987	2,803	574	3,377
1988	2,871	529	3,400
1989	2,955	490	3,445
1990	2,974	428	3,402
1991	3,074	457	3,531
1992	3,014	575	3,590
1993	3,100	415	3,515
1994	2,887	310	3,197
1995	3,051	316	3,367
1996	3,156	287	3,442
1997	3,260	258	3,518
1998	3,364	229	3,594
1999	3,469	200	3,669
2000	3,573	171	3,745
2001	3,678	143	3,820
2002	3,729	99	3,828
2003	3,703	121	3,824
2004	3,703	121	3,824
Increase % pa	1.60%	-8.00%	0.40%

Table 7: Canterbury Coal Consumption by sector (TJ) [6]

rail link is thus a vital link and a critical export lifeline. The considerable vulnerability of earthquake risk is a major issue, and becomes an extreme economic risk for the region and South Island users. Peer review has noted that further clarification on the relative proportions of export vs domestic consumption of West Coast coal would be useful. This point has been noted for future consideration. The vulnerability of the rail link may affect South Island coal users as well as the port.

Wood

Canterbury is a relatively small player in the NZ forestry sector despite having a considerable forest estate with only 6.3 percent of NZ's total forest estate. Some forestry statistics, focusing on the Canterbury region are shown in Table 8.

Forest harvest is likely to decline in future years with conversion of parts of the forest estate to pastoral use already taking place. The extent to which future forest conversions

occur will be very dependent on the further development and availability of irrigation. The Peer Review posed the question, "Do the government's greenhouse policies impact on the ability of landowners to convert forestry to dairy?". This question should be investigated further in Stage 2 as the issues involved may have a large bearing on the future direction of the forestry industry.

Reliable data or statistics on wood as a source of energy are understandably difficult to obtain. This has to do with a multitude of factors. One key factor is that wood's effective energy content is highly dependant on species and moisture content at the time it is consumed.

For domestic firewood, the wood is usually obtained from small-scale merchants, some of which may be cash-based suppliers, and possibly operating in the informal economy. Many consumers may be self-providers [15],

	Area (ha)	Standing volume (000 m ³)	Area-weighted average age (years)
Canterbury wood supply region			
Hurunui District	39 632	5 901	13.71
Waimakariri District	14 840	2 207	13.17
Selwyn District	15 761	2 998	15.68
Christchurch City	2 648	509	16.45
Banks Peninsula District	7 788	762	13.31
Ashburton District	3 855	653	15.62
Mackenzie District	5 135	682	14.86
Timaru District	12 091	1 482	12.57
Waimate District	12 981	1 510	12.90
Region total	114 731	16 704	13.85
South Island total	540 167	86 682	13.61
New Zealand total	1 811 180	400 356	13.93
Production		(000 m³)	
Canterbury region		760	
South Island total		4 600	
New Zealand total		19 261	

Table 8: Canterbury Forestry Statistics [14]

obtaining supplies from sources such as demolition lots, land clearing, forest arisings, wind thrown wood and general scavenging. Here, even for commercial supplies, quality may be uneven and quantities inexact.

In the residential sector, the use of firewood for space heating is undoubtedly common and significant. Its share of (input) energy for Canterbury households is estimated to have increased from around 16.7% of consumption in 1982 to some 21.6% in 2004 [6]. However, whilst domestic use continues to dominate the use of woody biomass for energy, it is actively discouraged as a future option. Pellet fuel alternatives are generally more expensive than competing technologies.

ECan's Clean Heat Project, designed to meet The National Environmental Standards for Air Quality (NES) by 2013 requires the replacement of old style (pre-1992) fuel burners and open fires; and their substitution with 'clean' (air emission) alternatives. Already there is evidence to show that around 60% of conversions have been to heat pumps. This has the effect of reducing the consumption of firewood and increasing the consumption of electricity, the latter effect particularly impacting on the important aspect of peak load.

The use of wood residues in the industrial sector, almost entirely by wood processors themselves, is estimated to have increased

substantially [6] in the last 20 years or so, increasing from around 2.3% of industrial/commercial energy consumption in 1982 to some 7.7% in 2004 in the Canterbury region.

Other Emerging Energy Sources

Biofuels

The double imperatives of seemingly enduring higher and increasing oil prices and the need to control and reduce greenhouse gas emissions, especially from transport sources, has resulted in renewed and likely ongoing interest in the development of biofuels, in the form of either bioethanol or biodiesel, as a substitute for traditional transport fuels.

To this end, the Royal Society of New Zealand (RSNZ) has recently released a study offering an environmentally more benign future for New Zealand energy [16].

The RSNZ Energy Panel presents a case for New Zealand not only replacing its current transport fuels with bioethanol but also developing the industry for exports. The report claims that New Zealand has around 3 million hectares of low value agricultural land that could be more profitably used to grow biofuels crops. Of this area, 2 million hectares are in the South Island, much of it in the Canterbury region.

While the description of their case is ambitious and seems over-optimistic, there seems little doubt that biofuels, initially made from sources such as tallow from dairy processing and “waste” oils from food preparation, will play an emerging role in New Zealand’s transport fuels sector, given government mandates and tax concessions.

As an indication of the interest in biofuels, ECan has extended its biodiesel blend trials which began in September 2006. One bus fleet operator is now undertaking a full urban bus fleet trial with a 5% blend [17]. Additionally, two buses are being trialled on a 20% blend. The biodiesel is made from vegetable oil and animal fats, supplied from Auckland.

It is beyond the scope of this study to offer an authoritative analysis of biofuels, the merits and economics of various feedstocks and the merits of bioethanol vis-à-vis biodiesel. However, the Canterbury region potentially may well be one of the more promising regions within New Zealand for the growing of bioenergy crops.

The core question remaining unanswered is whether such an industry is likely to emerge without substantial increases in irrigation loads and, if irrigated, whether such land can truly be classified as of “low-value”. It seems unlikely that once water is costed into the equation that the economics of crop-based biofuels will be at all favourable.

Landfill Gas

The Christchurch City Council recently announced the sale of 200,000 carbon credits to British Gas, which will return around \$3 million

to the Council between 2008 and 2012 [18], the first commitment period of the Kyoto Protocol. This is believed to be a first for New Zealand.

The credits have been awarded for the capture of methane from the closed Burwood Landfill. The methane is to be piped to QEII Park to heat and power facilities.

Since methane is one of the worst greenhouse gases, and seemingly less amenable to mitigation than carbon dioxide, this scheme represents a win-win situation, albeit on a small scale. Not only is there a revenue gain from the sale of credits, the capture and use of the methane will, from March 2007, replace around 1.5 million litres (40 TJ approx) of LPG per year.

Peer review noted that other emerging energy sources have been overlooked and should be included in further stages of the project e.g. solar energy, reticulated gas within Christchurch City and emerging wind power developments such as Gebbies Pass. Also noted is the omission of a summary of the current end use of energy e.g. how much energy is being used for heating, lighting, industrial processes etc.

More information on the end-use of energy in the residential sector may be found in Nigel Isaacs’ paper *The Need for New Electricity Generation – The Role of Demand* (downloadable at www.branz.co.nz/branzltd/pdfs/NZ_Energy_Policy_Demand.pdf) and in the HEEP work undertaken by BRANZ.

Stage 2 could use this information to identify whether technology or policy changes/improvements could change energy requirements and/or usage patterns and the implications for long term energy security.

6 REVIEW OF ELECTRICITY SUPPLY ISSUES

Overview

As part of this work the study team undertook a detailed assessment of the system characteristics and the factors likely to influence possible approaches to meeting perceived constraints. The outcome of this assessment is summarised below:

Regional Demand Growth Overview

As previously discussed, the networks within the Canterbury and South Canterbury regions are seeing annual energy (GWh) growth rates between 2 and 3% and peak demand growth rates of between 1% and 2%. Current demand for each of the regional distribution companies is outlined in the table below [19]-[23]. Note that the value for Network Waitaki included here is the whole Network Waitaki network, including the area inside the Otago region.

Company	Maximum Demand (MW)
Network Waitaki	32
Alpine Energy	103
Electricity Ashburton	95
Orion	577
CCC	10
MainPower	79
TOTAL	896

Table 9: Regional Maximum Demand

The types of demand can be considered to be in one of two very broad categories, either urban or rural. Urban loads are mostly comprised of residential, commercial and industrial demand whereas the majority of rural demand is irrigation load.

Energy demand forecasts for the region generally track the medium trend forecasts from the Electricity Commission of approximately 2% per annum. This presumes that the region's load growth matches that of the rest of the country. This seems an unlikely situation if one accepts the population and economic growth prospects described earlier in this report.

Maximum peak demand is a hard quantity to predict as it is very dependant on the weather, which in the Canterbury/South Canterbury region can be quite volatile. This volatility is present in both summer, from irrigation (a dry year results in large irrigation load) and in winter (from heating). If the system is running very close to its limit, then unexpected cold weather can result in capacity constraints that were not planned for.

Many of the urban GXP's in Orion's network are forecast to run into firm capacity constraints within the next 5 to 10 years. Islington and Bromley are the worst affected, with potential problems also surfacing at Addington, Springston and Hororata. There are a number of projects already planned to relieve or partially relieve some of these constraints. There is no reason to presuppose that other constraints will not be similarly dealt with through Orion's normal planning and investment cycles.

All the network companies within the region reported load factors between approximately 60% and 65%, this being quite high in some areas such as Network Waitaki (which is a predominantly rural load). In rural areas where load growth is predominantly in irrigation, the load factor is expected to decrease over time. This is due to the daily load factor (in summer) being high but the annual load factor of irrigation being low. In networks such as Orion's, the load factor is expected to remain steady as the effect of irrigation on load factor is offset by commercial and industrial loads that have high annual load factors.

Demand growth in Canterbury and north in Nelson/Marlborough is putting significant strain on the transmission system running from the southern generators up the island. Transpower has recently commissioned another circuit north of Christchurch to Kikiwa but capacity on the lines running into Christchurch is already stretched and will continue to worsen. As previously discussed, Transpower is looking at a number of alternative solutions to this issue. Current proposals are for a number of small

capacity increments using improved bussing and transformer ratings/capacity in locations such as Islington, Bromley and Ashburton and series compensation of the transmission circuits supplying Canterbury.

These projects may culminate in a new transmission circuit from the southern generator region into Christchurch in the future.

Interregional Flows

During normal operating conditions, the Canterbury region receives power from the southern generators. Flows into Canterbury come from the south and then flows out toward the West Coast and north to Nelson and Marlborough. As Canterbury is so dependent on power produced outside of the region, having adequate transmission to accommodate the flows servicing local loads is very important. The following diagram illustrates the typical flow of power from southern New Zealand into Canterbury and further north to Nelson/Marlborough.

Canterbury currently faces operational constraints in the regional transmission grid, which is affecting the delivery of electricity from generation centres in South Canterbury and the

North Island to the main regional demand centre of Christchurch. Figure 8 provides an illustration of this point.

Interpretation of the figure shows that N-1 adequacy (with proper reserve margins) is only achieved through peak load shedding, indicating that the system is at least partly constrained.

Other Dimensions to the Supply/Demand Problem

Urban Issues

The Christchurch region has the largest urban load with the major driver for demand increase being influenced by methods contained in ECan's Air Plan (*Proposed Natural Regional Resource Plan*, Chapter 3, 'Air Quality'). The key method is the Clean Heat programme. This programme aims to enable Christchurch to meet the national air quality standard that is to be implemented by 2012. The impact of Clean Heat is to remove open fires and restrict the use of inefficient fuel burners and substitute their use with 'clean' alternatives.

To date, approximately 65% of conversions have been to heat pumps. The continuing

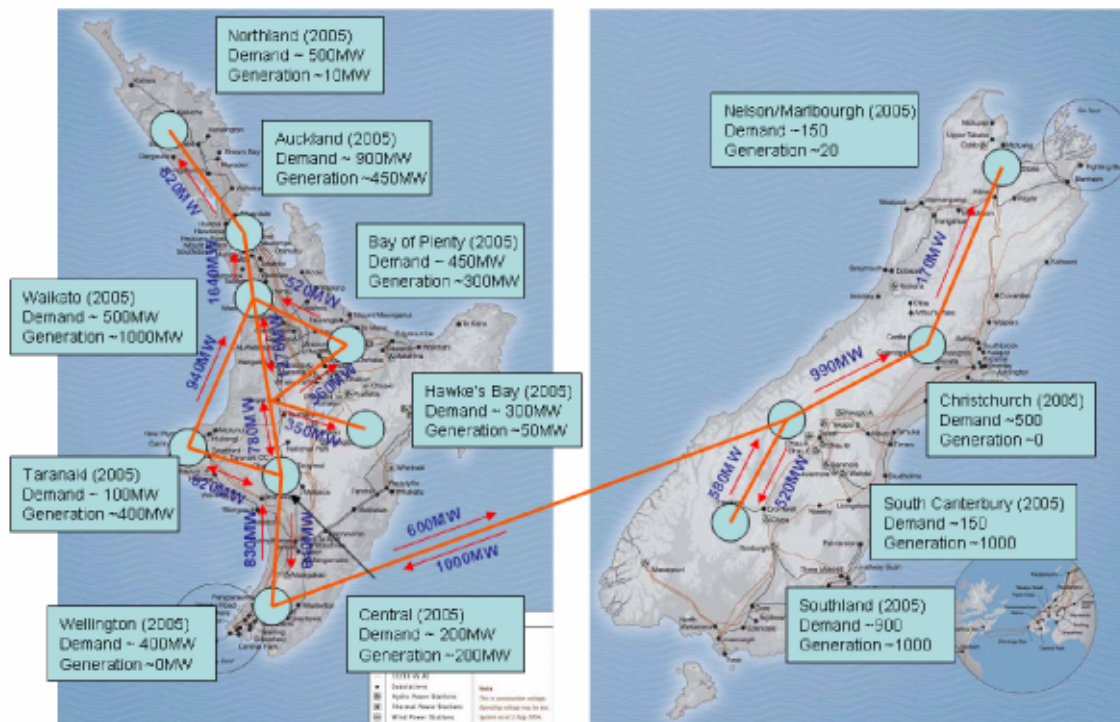


Figure 7: Inter-Regional Electricity Flows [24]

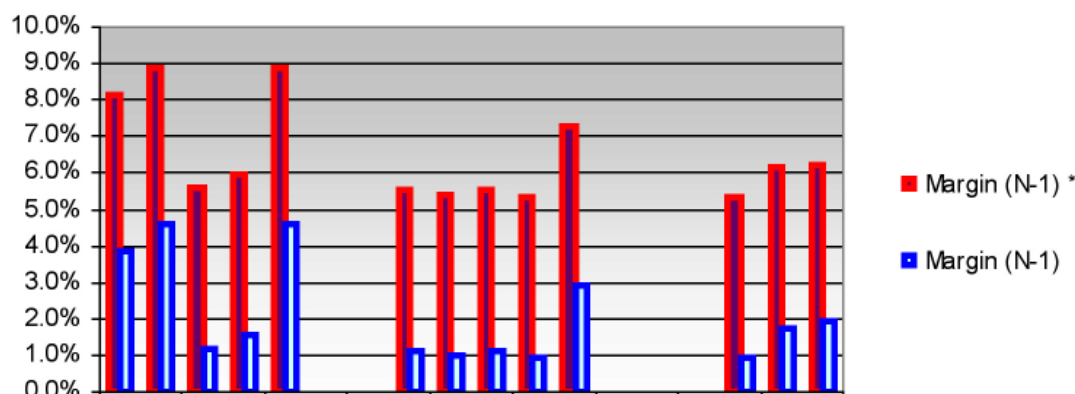


Figure 8: Upper South Island – Winter 2006 Transmission Adequacy [25]

NOTE: The blue bars indicate the available reserve margin within the transmission system at the dates shown above while the red bars represent an increase in the reserve margin achieved through load shedding of peak demand.

switch to alternative heating options is predicted to increase peak winter demand by 30 MW in the next seven to ten years. The increase in heat pumps may also lead to increased summer peaks due to an increase in air conditioning load though definitive data for this is not yet available.

The urban load duration curve is very flat, in that for most of the year the load deviates very little from its median value. The following diagram taken from Orion's AMP 2006 [19] shows the historical changes on the load duration curve where it can be seen that the maximum demand on the system only occurs

for a very small number of half hours per year.

The historical trend shows that the demand peaks are occurring less frequently, resulting in a flatter load profile.

Rural Issues

The largest issue in the rural category is the increase in irrigation load. In the last five to ten years, this growth has been very steep although forecasts looking forward indicate this growth is likely to slow. This slow down in growth is due to a number of factors including:

- ECAN's restrictions on ground water

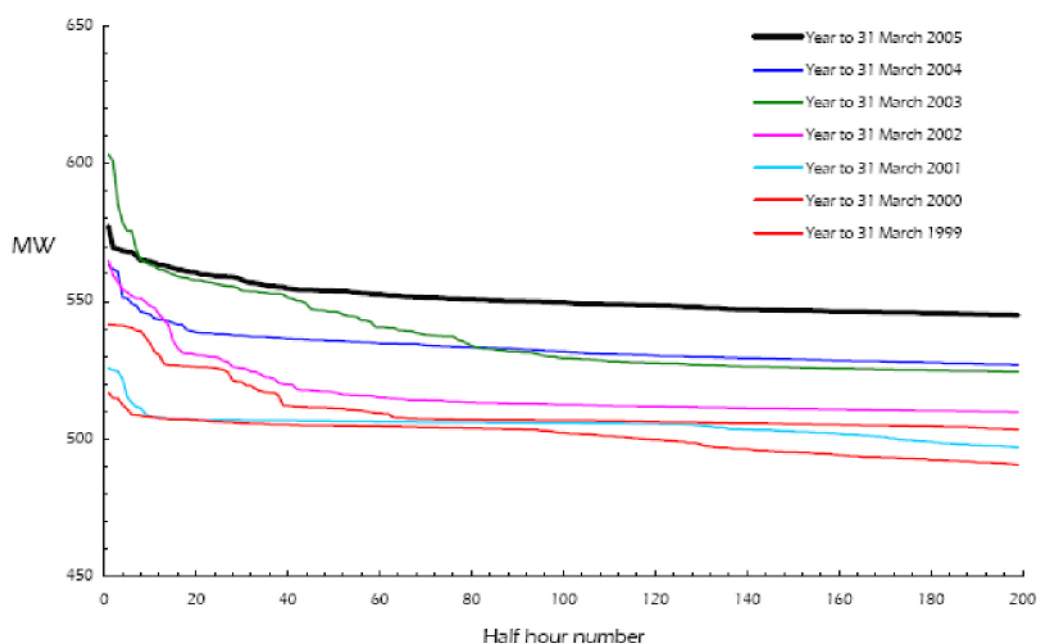


Figure 9: Christchurch Urban Network Load Duration Curve

allocation

- Land use in some areas is approaching full irrigation potential
- Interruptible load arrangements to cover short term faults
- Requirements of the central plains irrigation scheme.

Forecasting peak load growth due to irrigation is quite difficult due to the use of irrigation being very strongly correlated with weather conditions. The following graph shows the rural demand growth trend (for the Orion Network but not for Canterbury as a whole) and its volatility, mostly due to vagaries in the weather. We believe this issue is also common to all networks.

System Risks related to the Regional Electricity System

Within any electricity system a number of factors combined with the performance of the system assets already in place create risks in investment, operation and security of the system. Patterns of energy use, interregional flows, age of assets, energy losses and asset utilisation all add to the risks the system faces.

Patterns of Energy Use

Different types of loads have different effects on the distribution of demand across the day and the year. Residential load has a low load factor and is a big contributor to demand peaks while commercial and industrial loads

have high load factors. Within Canterbury irrigation loads, as discussed previously, with a high daily load factor but low annual load factor are a special risk feature.

At a regional level, a more detailed development of our understanding of the different types of load growth is needed in order to optimally plan for the types of investments likely to be required in order to ensure the future adequacy of the system. The risks of not having a good forecast of energy use and its patterns of development include:

- Stranded assets resulting from investments in the wrong areas
- Small incremental investments becoming superfluous due to necessary large up-grades later on
- System capability being constantly stretched
- Volatility in prices resulting from capacity constraints and uncertain investments.

A significant issue for the region, therefore, is that without a single obvious “owner” responsible for investment decision making there is the potential that conflicting interests may well lead to a sub-optimal outcome. Thus this study and its ultimate aim to better characterise the vulnerabilities of the regional energy system as a whole. One can expect that through the sharing of information and development of joint approaches to these risks an improved framework for future decision-making will emerge.

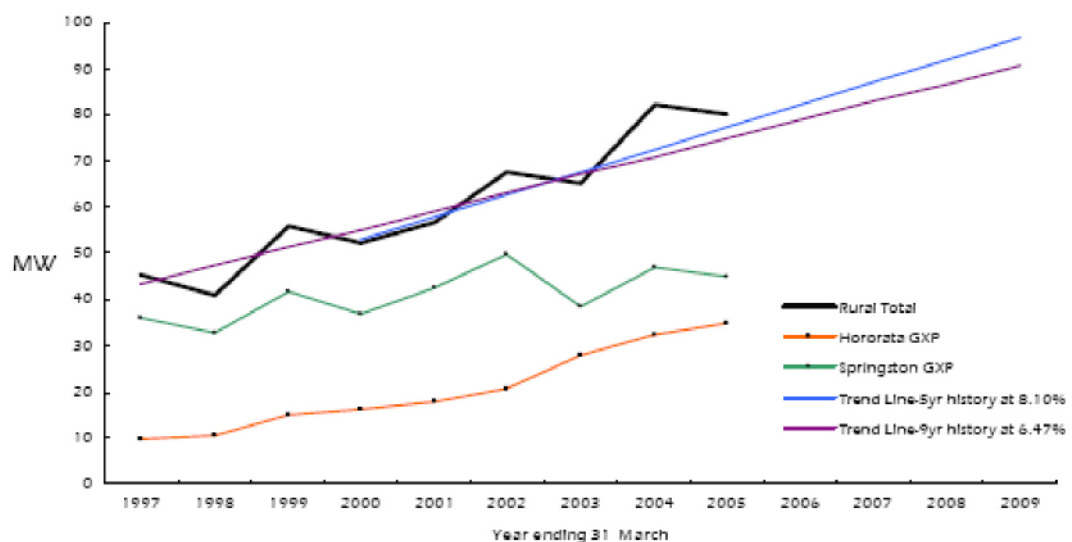


Figure 10: Rural Summer Maximum Demand Trends [19]

The information needed to track and forecast patterns of energy use should include consideration of regional land use plans, national energy policies, building and urban development patterns, population growth and other demographic policies that attract or repel investment in energy intensive industries and long-term climate trends. Canterbury, at the regional level, currently falls well short of this level of analysis and understanding.

Age of Assets

There is a vast range in the age of assets throughout the networks in Canterbury. Continual upgrade of assets occurs as a matter of course and maintenance schedules are planned accordingly. As assets age they are more likely to:

- Become inefficient causing higher system losses;
- Possibly be the cause of faults impacting system security (although where N-1 or N-2 security has been implemented, these faults are unlikely to result in an outage);
- Require more maintenance resulting in more outages to get maintenance work done.

While the majority of power system assets are designed to be in active use for 50 years or more, they often require partial investment to upgrade their efficiencies or useful lifespan. Older assets require parts that may be hard to source and hence may not be immediately available during fault situations. This results in potentially longer outages, reducing the level of service to customers. The risks of aging assets include:

- Hard to obtain repair parts easily resulting in longer outage times
- Potential lower level of service to customers due to faults and outages resulting in increased costs to customers, customer loss or complaints.
- An inefficient system due to standing losses.

Gaining an overall impression of the age of assets can be hard to determine, as it will vary widely between assets types. Whilst not generally reported, it is suggested that a more useful measure would be the expected life

remaining in assets and whether they are currently scheduled for replacement before their life expectancy is reached. Alongside this, some analysis of the risk associated with assets at their current age, defined in terms of risk of failure causing an outage may be useful in quantifying the risk associated with the asset age.

System planners usually take into account many of these age risks when considering upgrade plans for their network. Further consideration of these issues may be warranted to achieve consistent performance standards across the region.

Energy Losses and Delivery Efficiencies

By reducing energy losses and increasing efficiencies, a greater output (energy utilised) is received for a smaller or similar size input (power generated). Not taking full advantage of fewer losses and greater efficiency results in risks that include:

- Reaching capacity limits faster than necessary
- Wasted energy
- Using more generation resources than necessary.

Potentially resulting in:

- Generation constraints
- Transmission Constraints
- High prices and nodal volatility.

At the detailed level, information on losses and efficiencies is likely to be a combination of the asset design information, the configuration used, and the age of the asset. This would give very detailed information for particular areas but a more general approach may be a sufficient level of detail at the regional level.

A following systems approach would provide a greater insight on a regional level:

$$\text{Energy in (interregional flow)} = \text{energy utilised} + \text{energy out (interregional flow)} + \text{losses}$$

Again, such information is typically maintained in-house and rarely shared amongst industry participants in ways that can help better align investment decisions. There is currently no

measure of the delivered energy efficiency for the Canterbury Regional Energy System. Publication of such a measure would do much to give confidence to end-users and other stakeholders of the performance of the electricity delivery system.

Asset Utilisation

Asset utilisation is a balancing act between getting a good return on the capital investment, i.e. using the asset as much as possible to improve income, and making sure there is enough spare capacity to accommodate load growth for a suitable period of time. It is the trade off between large scale investment and small incremental investment.

Where the need for an investment to accommodate growth is obvious, fairly certain and economic, there is less risk in investing in assets that may not be fully utilised initially. If, however, there is uncertainty surrounding the investment (such as the size, location or best improvement to be made), small incremental investments are often useful while the uncertainty resolves itself. The level of uncertainty, and hence the risk that is prepared to be taken, when deciding on large-scale vs incremental, typically depends on the scale and cost of the investment decision.

The risks associated with either large scale or incremental investment in terms of asset utilisation include:

- Low asset utilisation as a result of unrealised growth, over-investment or large scale upgrades can result in:
 - Stranded assets
 - Wasted capital expenditure
 - Low return on investment
- High asset utilisation as a result of incremental investment or higher than predicted demand growth results in:
 - Greater return on investment
 - The system may face constraints more often, resulting in volatile prices
 - Greater disruption (loss of supply to customers) to the system when the asset is removed during faults or maintenance

- Harder to find windows for maintenance due to high loading conditions. This may result in longer periods between maintenance than the ideal, increasing the risk of faults.

At the expert level, information about asset utilisation is almost always reflected in system constraints. Assets that are frequently implicated in a system constraint are likely to have high utilisation. Finding assets with low utilisation requires comparing ratings of equipment with average and peak energy flows (or appropriate measure for the asset concerned). Another option for identifying areas that may have high asset utilisation is through studying nodal volatility. High volatility may indicate stretched capacity or constraints and hence high asset utilisation.

These system risks are not well understood particularly with how they relate to and impact on the vulnerabilities of the power system. This is an area that requires expert opinion and agreement on what constitutes an adequate spread of the risks. It is suggested that this would be a fruitful area for further industry discussion and review.

Standards for Security of Supply

Defining the issues

In New Zealand, each market participant has the ability to plan and operate their assets to supply their own desired level of security. There is currently no standard that must be applied uniformly across the system, only guidelines that companies may pick and chose as to what they implement.

A useful basis for guidelines on security of supply is the document produced by the Electricity Engineers Association (EEA) in June 2000 entitled “Guidelines for Security of Supply in New Zealand Electricity Networks” [26]. The Guidelines state that they are not intended to be mandatory but, in the opinion of EEA, they are considered to be good practice for application in New Zealand. They are specifically intended for distribution network or lines companies and can be used for their Asset Management Plan disclosures under the

Electricity Act (Information Disclosure) Regulations. These Guidelines were developed after the Ministerial Inquiry into the Auckland Central Business District power failure in 1998 recommended that guidelines be prepared for security of supply in New Zealand electricity networks. Table 10 provides the Security of Supply Guidelines as developed by the EEA.

In addition to the above, the Electricity Commission has recently completed a review of grid security including consultation with electricity industry participants and major customers. The review concluded that loads above 150MW must have N-1 security and that loads below 150MW will be subject to probabilistic economic analysis on a case-by-case basis. While the EEA guidelines provide a basis for companies to base their security criteria on, they are by no means universally adopted throughout the country. Regionally, it may be that the guidelines do not adequately reflect the security requirements of different load types as many areas have unique demand profiles.

System reliability can be considered to be the summation of system adequacy and system security. Adequacy and security are conceptually different. Security is the ability of the system to continue supplying load under a fault situation whereas adequacy is the ability of the system to supply loads under different operating conditions and provide adequate capacity in the system to provide reasonable cover for unseen events (e.g. dry years, cold

weather).

A major focus of the work undertaken in this Stage 1 was to examine the various factors that would influence security measures and vulnerabilities for the Canterbury region and to see to what extent it was possible to arrive at a consensus view from the various contributors to the project. Adequacy has not been fully addressed.

Security of Supply for the Canterbury Region

Based on the current N-1 security criteria used for planning by Transpower, a number of vulnerabilities in security are seen in the Canterbury region at both the core and non-core grid level. These vulnerabilities in the grid are highlighted by the differences in security criteria seen within the region at distribution network level. Distribution networks often have alternative security standards for different load groups that don't necessarily match the security criteria of N-1 used by Transpower.

However, it should be recognized that at the sub transmission or distribution level (i.e. the domain of lines or networks companies), maintaining N-1 security may not be the best solution for all market participants as the costs of implementation may be greater than the value delivered in certain situations.

System adequacy is considered by the region's network companies in their Asset Management Plans and also addressed in the EC's Statement

(The Guidelines provide a framework only, and it is intended that systems planners/network managers should set their own standards for security of supply applicable in their network.)

Class Of Supply	Range of Group Peak Demand (GPD) MVA	Typical Examples	Minimum Demand to be met after		
			First (Tx/cct) Outage	Second (Tx/cct) Outage	Busbar Fault
A	0 - 0.5	Customer Connections	Repair Time (Note 1) 100% GPD	Repair time (Note 1) 100% GPD	Repair time (Note 1) 100% GPD
B	0 - 1.5	Urban Low Voltage meshed distributor. Rural radial feeder. Urban small radial feeder.	Repair time - 100% GPD	Repair time - 100% GPD	
C	Up to 12	Rural meshed network. Rural district substation. Urban meshed network (open rings) Rural GEP's (Note 5)	Within 3 hours - 50% GPD Note 2 In Repair time - 100% GPD	Restoration, Or in repair time - 100% GPD	Repair time - 100% GPD
D	over 12 - up to 60	Urban closed ring networks, district substations, major switching stations.	Immediately - 100% GPD less 12MVA. Remaining 12 MVA - 3 hrs	Restoration Or in repair time - 100% GPD	
	Over 12 - up to 40 (Remote Point of Supply)	Remote Region GEP's/district substations	Switching time - 75% GPD Repair time - 100%	Restoration Or in repair time - 100% GPD	
E i	60 - 200	Large industrial customers. Major city CBD's	Immediately - 100% GPD less 12 MVA. Remaining 12MVA - 3 hrs.	Within 1 hour - 100% GPD less 12MVA. Remaining 12MVA - 3 hrs	Immediately - 50% GPD. repair or restoration time - 100%GPD
ii	40 to 300 (Normal Point of Supply)	Normal GEP's (dual circuits/transformers)	Ditto	Switching time - 100% GPD less 12MVA, Remaining 12MVA - 3 hrs	Switching time - 100% GPD
F	300 - 600	Larger GEP's:- Three circuits (on two routes); Three busbars; Two or more transformer banks.	Immediate 100% - GPD	Switching time - 100% GPD	Switching time - 100% GPD
G	>600	More than one major terminal substation in region. Note 3.	Immediate 50% - GPD Switching 100% - GPD	Switching time - 100% GPD	Switching time - 100% GPD

Notes:

- 1) The timescale for the repair/provision of temporary supply should be set as part of the Line companies Service Level Guidelines. See also clause 9.1.6.
- 2) In remote areas it may prove uneconomic to provide any switched alternative supplies to very small, (<12 MVA) GEP's.
- 3) For example, two or more GEP's in region, only one supply (or it's equivalent) should be lost on the first outage.
- 4) This table must be read in association with the rest of the Guideline document particularly in relation to the application of the analysis of a network and the resolution of the action to take.
- 5) GEP - Grid Exit Point.

Table 10: EEA Security Guidelines

of Opportunities (SOO) [11]. At the core grid level, it seems likely that Canterbury will face an ongoing energy imbalance despite the potential generation modelled in the EC SOO scenarios as shown in Figure 11.

This problem is characterised by the decreasing supply margins highlighted in the recent Canterbury Manufacturers Association analysis of the Canterbury electricity supply situation (Figure 12 [27]).

Transpower last year sought information on potential alternatives for meeting supply security. The process for addressing the issue was summarised by Transpower at the first CRESG Workshop on 7 September 2006. To date the most feasible options as Transmission Alternatives identified by Transpower are:

- Installation of diesel generators in the Upper South Island up to 30 MW
- Demand management (including efficiency increases) up to 73 MW

As a result of their preliminary investigations, Transpower have publicly indicated that any major grid upgrade may be able to be deferred from their original timeline of 2012.

Associated with the grid security considerations is the load profile of the Orion network, which currently requires large amounts of peak shifting to be undertaken to flatten out demand over normal peaking times. Whilst this is a useful contribution at the local level, wider

issues surrounding overall system adequacy means that continued reliance on this capacity to peak shift in order to provide N-1 security for the wider transmission network may, or may not, offer the best solution for the region. While load management clearly has a role to play in supporting system adequacy, the degree to which this should be relied upon, given the broader regional implications, requires further review and discussion between regional stakeholders before an adequate basis for determining system security can be confidently reached. Peer review noted that load shifting is a valuable contribution in supply security and should not be discounted or ignored. It was also noted that no discussion of the cost of load shifting is presented. If cost allocation mechanisms are used, it is possible there will be a resistance to use load shifting at a future point in time and therefore load forecasts based on load shifting may understate the actual electricity demand.

Similarly, distributed generation may not to be a satisfactory response both at transmission and sub transmission levels for maintaining N-1 security levels under all operational conditions. Potentially, new generation in the Canterbury region will expose the upper South Island by providing incentives to defer investment in the transmission grid, thereby increasing nodal risk and retailer exposures, which might possibly result in higher regional electricity prices. This issue will be investigated further in Stage 2.

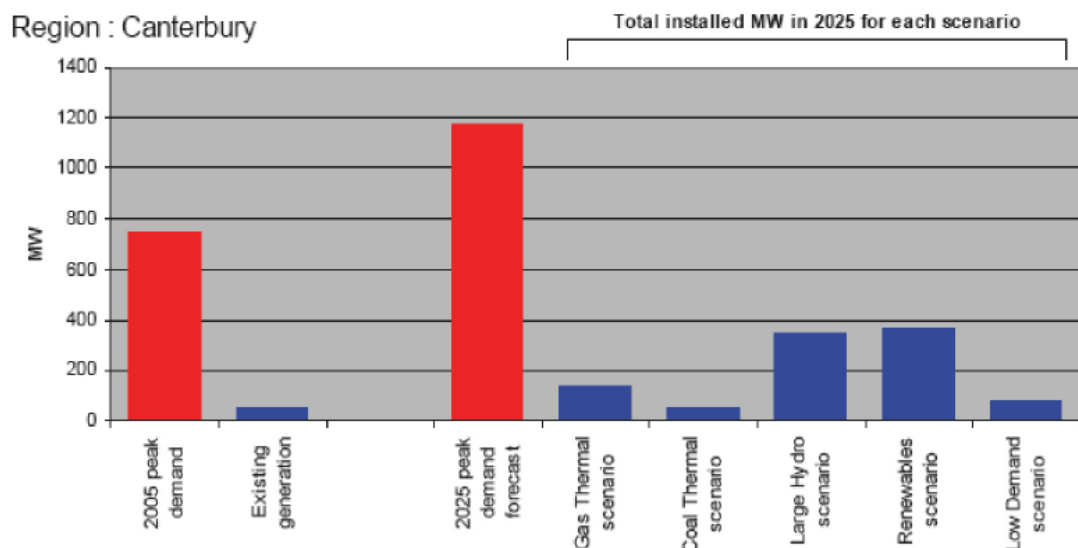


Figure 11: Regional Demand vs Generation 2005-2025 [11]

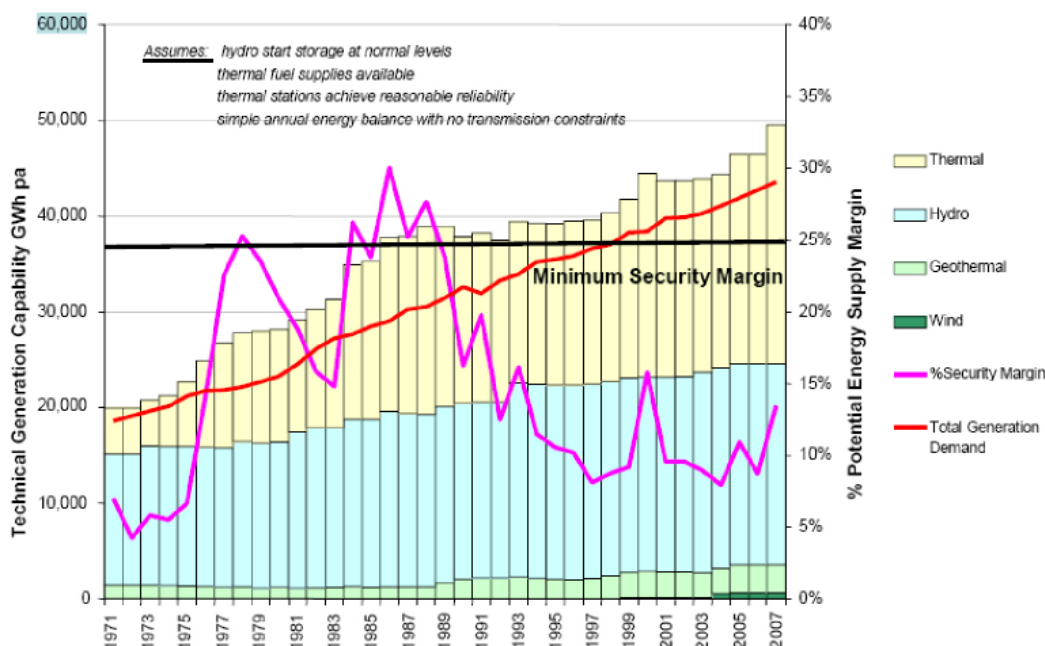


Figure 12: Decreasing Security Margins [27]

Transmission Planning and Regional Benefits

The EC's principle objectives are to ensure that electricity is produced and delivered to all classes of consumers in an efficient, fair, reliable and environmentally sustainable manner, and to promote and facilitate the efficient use of electricity.

A core function of the EC is to administer the Grid Investment Test (GIT) in determining the appropriate investment path going forward for Transmission planning. A submission to the EC on Transpower's 400kV investment proposal for the Auckland region by The Energy Centre at the University of Auckland [28] highlights a number of areas that the GIT appears to fall short in meeting broader national objectives.

In particular, the Energy Centre analysis suggests that the GIT ignores the effect different transmission decisions have on resulting generation scenarios. Analysis of generation scenarios resulting from specific transmission decisions (missing from the GIT) could have a direct effect on Climate Change obligations or the National Energy Strategy. An example being where a deferred transmission investment results in installation of a thermal generator to meet short-term capacity issues, thereby resulting in increased CO₂ emissions.

Generation investments (and hence costs) benefit from a reduction in risks and uncertainty; an important component of which is longer-term certainty and security regarding transmission pathways. Transmission deferral does not create certainty. The Energy Centre analysis suggests that the GIT as presently applied misses or underestimates these and other important benefits, especially concerning the competition benefits of 'excess transmission capacity'.

These issues surrounding interpretation of the GIT are very relevant for the Canterbury region. Sustainability, interdependence of transmission and generation and the influence that transmission capacity has on competitive market behaviour within the region are some of the important issues identified in planning for future investments.

Other areas identified that need to also be considered in the planning process are discussed in the following sections.

Market/Risk Vulnerabilities

Planning for N-1 security on the grid doesn't appear to allow enough flexibility to mitigate nodal risk. This can result in constraints and lead to price spikes.

In the recent past the general consensus is that market signals were not being seen in sufficient time to plan for future investment before security becomes an issue. Simple reliance on price signalling also has the effect of reducing demand growth. When customers have more visibility of their electricity prices they are able to make better decisions regarding usage, load shifting or load reduction. While Orion's current policies do this to some extent, more could be made of the ability to influence demand by providing price information to consumers.

One issue yet to be resolved is how to balance the effects of local constraints against overall system adequacy. This requires that market price signals are sufficient to encourage short-term tactical responses, but also any market mechanism needs to ensure that relatively high cost supply constraints can be commercially contracted to guarantee long term system performance. For example, how will a local embedded generator contracting for the supply of grid capacity support also provide the required pricing risk cover to all grid loads affected by any future failure of this service? The Study Team suggests that a reliance on the current market mechanism creates uncertainty for consumers, leading to higher prices.

Canterbury could benefit from 50MW of peaking plant in order to delay transmission investment. This investment, if measured solely on the basis of the amounts of electricity generated, may not by itself be economic but incorporating the savings from delaying transmission investment could make it economic. Thus, as noted above, for the peaking plant owner to provide an alternative to transmission, there needs to be an economic cost recovery from the grid owner or some form of market transfer price (hedge) for the constraint being managed.

Accordingly, the evidence suggests that reliance solely on the market tends to favour small incremental investments. In a perfect market situation, these incremental investments would be guaranteed to occur and a perfectly balanced system would result. In reality, uncontrollable delays such as the RMA consent process, technical failure or 'bankability' can cause each incremental investment to fall

further behind from when it is needed. As each incremental investment is delayed the ability of the system to cope with the shrinking reserve margin (offered capacity less demand) is reduced. This is where the system starts to be constrained.

A suggestion to mitigate this issue is to use the advantages of economies of scale and combine increments into a larger investment. There is a risk that the current market investment model doesn't put enough emphasis on the benefits of economies of scale and, hence, the overall system is sub optimal.

The risks associated with incremental investment include:

- Capacity in the system is always stretched as investments are small and "just in time".
- Price volatility and nodal risk is high
- Much more difficult to plan for large investments due to uncertainties in the future being too hard to quantify satisfactorily.
- Economies of scale may be lost when they could be used to overcome the uncontrollable delays occurring in incremental investment.

The risks with large-scale investment include:

- 'gold plating' the network
- Inefficient use of capital
- Stranded assets when demand or supply doesn't eventuate
- Price volatility is low – this is not a risk but the true cost of electricity may not be transparent.

The risks between incremental and large-scale investment are a balancing act between efficient use of capital and ensuring adequate capacity and security to facilitate regional growth.

Many of these risks do not have an immediately identifiable solution to address the vulnerability. Most solutions result in a trade off between risk and investment and it depends on the companies involved as to how much risk they are prepared to accept and ultimately system reliability.

Nodal Risk

Operational issues which arise in managing N-1 security on the transmission system into the Canterbury region have, at times, resulted in Grid Emergency Notices being issued. These notices have a tendency to induce price spikes and hence increase nodal risk. This risk most affects retailers and consumers rather than the transmission owner and results in concerns that planning for and operating to an N-1 security level doesn't allow enough flexibility to manage nodal risk successfully; i.e. investment windows get shorter.

As previously described, supply to Christchurch needs to be improved in the near- to medium-term in order to continue meeting the N-1 security standard. Anecdotal evidence suggests that without explicit action, nodal risk will be very high before such upgrades are commissioned.

Nodal pricing risks are a combination of two things: "Nodal loss factor of core grid", known as ACLF (AC Loss Factor); and "nodal constraint factor", made up of system constraints and price differentials. The nodal loss factor can be quite high when it is considered that the geographic load centre is situated near to Hamilton and the geographic generation centre is at Benmore.

Data supplied by Meridian indicates that nodal pricing risks can range from 13 – 20% of nodal \$/MWh prices. Based on an average wholesale price of \$65/MWh, pricing risks can account for between \$7 – 14/MWh. This is a high value risk when the normal price net margins for retailers are in the order of \$3 – 5/MWh in present market. The \$7 – 14/MWh nodal risk, if unhedged may swamp the normal net retail margin and be unprofitable leading to retailers reconsidering their growth options in regions with high nodal risk. It will depend on the availability of constraint hedges and/or the risk acceptance of the individual retailer as to whether they continue to trade in an area with high nodal risk. In either case, the consumer is likely to pay a risk margin for the constraint and in many areas this margin may well be higher than the transmission or network avoided upgrade costs.

Where the nodal risk is greater than the profit

margin at a node, the node becomes more unprofitable and market participants are likely to either increase prices or shy away from supplying load at that node. Either option can be seen as undesirable for a region. It will depend on the risk acceptance of the individual retailer as to whether they continue to trade in an area with high nodal risk.

However, new rules regarding Transmission Rental Rebates are expected to be introduced in the next two years that will materially affect the way in which nodal pricing is distributed across the industry nationally. It is anticipated that under these revised rules, retailers will move closer to a zero sum position and that high PCN prices will be a much lesser concern. This is a complex area relating to competitive balance and individual participant capacity to "self-cover" the contingent risks. It remains an area for further consideration in the context of national grid investment versus local transmission alternatives.

Supply Chain Risk

The overall supply chain needs to work cohesively so that no one part of the chain puts undue risk on the electricity supply to the region. The supply chain consists of generation, transmission, distribution and retail. With each part of a supply chain ideally being equally responsible for security, assessment of the current situation in Canterbury would be a useful planning tool to show the various strengths and weaknesses. This would allow for appropriate investment in different areas.

Whilst South Canterbury is a major exporter of electricity to the North Island, Canterbury has very little other generation, so the focus for security of supply within the region is on the transmission system. If no generation is installed, it may be appropriate to ensure security of supply by investing in the transmission system over and above what would otherwise be deemed necessary, simply to ensure system security and adequacy. Alternatively, installing generation locally in an appropriate location may mean that transmission security is no longer a risk, provided nodal pricing risks for all local loads can be covered through market or off market hedge contracts. With either scenario the generation

section of the supply chain has increased security showing that there is often more than one potential solution.

Another view of security and risk in the supply chain as put forward by Network Waitaki is that there is no merit in delivering high security levels in only one part of the supply chain, if that standard is well beyond any security of supply delivered at the customer connection. Over-investing in any one part of the supply chain can result in wasted investment and overall higher costs.

Transpower plans and operates at N -1 security for transmission to avoid cascade system failure, but network companies can and do have different definitions of security for their individual networks. For example, Orion invests in their network to provide 'interrupted N -1'

security to certain groups of customers. There is very little scope currently for a customer to contract their desired level of security at a GXP and not end up paying for N – 1 security.

Given the widely varying circumstances within the region it may be appropriate in certain specific situations to relax the level of security if the associated costs are considered excessive.

There is thus a case for further exploring the “weakest link” in relation to Regional security of supply standards. Such a Regional cost-benefit analysis will assist in deriving the appropriate reserve margin for planning purposes and also contribute towards gaining a better understanding of the Region’s net contribution (import vs. export) to the wider national electricity system.

7 POTENTIAL FOR DEVELOPMENT

Because of the limited nature of this Stage 1 study, it has not been possible to provide a full assessment of the opportunities potentially available to the region to meet future energy needs. However, there is in the public domain a significant body of literature that describes these possibilities and the contributions that might ensure. We have not sought to replicate this work but instead selected a limited number of quite specific case studies so as to describe the nature of these opportunities and the likely ways forward.

Much more needs yet to be done to give effect to these opportunities and to clarify possible future pathways. In particular, we point to the fact that what is generally missing from the published information is a realistic appraisal of the price points at which individual supply options are likely to become commercially viable. This is work that needs to be carried through into Stage 2. Peer review noted that the context of the report could better promote the resources that Canterbury does have access to. The implications for Stage 2 could then be to identify the barriers which work against Canterbury, preventing its resources from being fully utilised.

Case Study 1: Oil Exploration

The occurrence of oil and gas in the Canterbury region has been well documented. The Canterbury Basin has a proven petroleum system with large mapped structures, and so far, one significant (off-shore) discovery. The first exploration well was drilled to a depth of 661m at Chertsey between 1914 and 1922. A further 2 wells were drilled onshore in 1969, reaching basement rocks at depths of 1650m (JD George-1) and 1159m (Leeston-1). Offshore, Resolution-1 was drilled by BP in 1975. Kowai-1 was drilled in 1978 in North Canterbury by the newly-formed state oil company, Petrocorp.

Clipper-1 was drilled offshore by BP in 1984. With a total depth of 4742m, this is the deepest well that has been drilled in the

Canterbury Basin, and recorded gas and condensate shows. Galleon-1, drilled immediately following Clipper-1 in the North Otago sector of the basin, successfully tested for gas and condensate. Both these discoveries were adjudged by BP to be sub-economic, mainly because of size.

Recent exploration has included further seismic surveys both onshore and offshore, and 2 wells were drilled in 2000: Ealing-1 in Mid Canterbury and Arcadia-1 in North Canterbury.

A further offshore prospect, Cutter-1, is scheduled to be drilled off North Otago starting in October 2006, by Tap Oil on behalf of a joint venture of Australian companies (Figure 13).

Tap Oil indicated potential reserves, if Cutter-1 is successful [29], of 50-80 million barrels of oil. They have also identified a potentially large (Maui-scale) gas and condensate prospect, Barque-1, in deeper water, east of Cutter-1. As yet, there is not a timetable for the exploration of Barque-1.

Besides the Tap Group's PEP 38259 offshore North Otago, there are two onshore permits and two other offshore permits in force in the Canterbury Basin, and two areas under application. TAG Oil has announced plans to drill two wells onshore in late 2006 or early 2007.

Economic Significance

While the Canterbury Basin has drawn the attention and investment of oil and gas exploration ventures over many years, until a discovery of commercial scale is made and developed, the potential resources that are thought likely to exist can make no contribution to the regional energy system. Conversely, a discovery of scale sufficient to justify development could transform the regional energy situation.

The promising results of Galleon-1 in particular, and the resumption in serious exploration investment represented by the pending drilling campaigns (both off and on shore), attest to a reasonable level of oil and gas industry

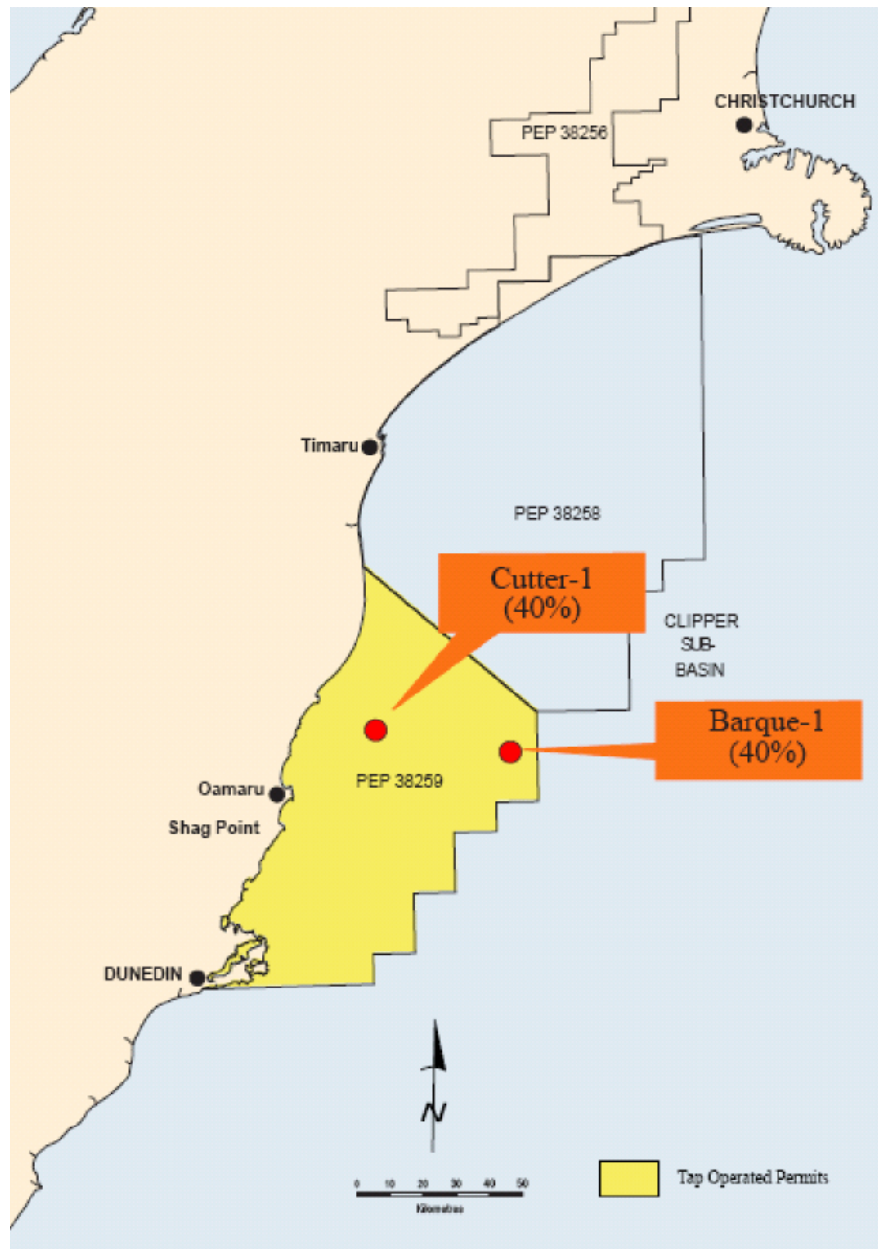


Figure 13: Location of Current Exploration Prospects in the Canterbury Basin [6]

confidence in Canterbury's potential. Realisation of that potential will require significant risks and costs to be overcome, not just in making a discovery but in its subsequent appraisal, development, and the associated development of an infrastructure for the processing and/or utilisation of production in the region.

An indicative economic assessment assuming a successful discovery of 80 million barrels of oil at the Cutter-1 prospect has been made for this study [30]. Some input assumptions, amongst others, include an oil price of US\$45 per barrel, a gas price of NZ\$5 per GJ and an

exchange rate of NZ\$1:US\$0.60.

A production profile for oil with associated gas and water based on Taranaki Basin "F-Sands" type reservoirs, is assumed, resulting in an economic field life of at least 8-10 years.

Based on development costs of US\$410 million and operating expenditure of US\$90-100 million p.a., the success case NPV for Cutter is estimated at around US\$610 million (around NZ\$1 billion), with a field value in excess of US\$7.50 per barrel.

Since Cutter is just 23km offshore east of

Oamaru and in around 75 m water depth, it may be regarded as a “near shore” prospect. Thus production could start as soon as 2010 should a commercial find be made.

Even though the oil is likely to be directly loaded on to tankers from a floating production, storage and offloading (FPSO) facility and shipped elsewhere for further processing, these figures clearly imply significant economic benefits for the region from the exploration, appraisal and, especially if successful, production phases of such discoveries.

More importantly, any successful discovery is likely to improve the prospectivity of the Canterbury Basin, eventually leading to more successful discoveries. It is the aggregate effect of such discoveries that may transform the energy supply picture and energy infrastructure of the Canterbury region, in particular, and that of the South Island.

Case Study 2: Natural Gas

The Cutter-1 prospect off the coast of North Otago has been described in the Oil section above.

Whilst Cutter-1 is an oil play, the oil reserves indicated might extend to around 50-80 PJ of associated gas. Flaring of the gas is not an option, (partial) re-injection might be costly even though it would likely enhance oil recovery, and so, ideally, a market should be found for the gas, if the prospect becomes a commercial oil discovery.

This amount of gas, of itself, is not sufficient to develop any high-pressure gas pipeline infrastructure locally or within the South Island. Production averaging around 6 PJ per year for less than 10 years does not provide a basis for the development of any enduring applications except on the assumption that a successful commercial discovery will likely lead to others.

One potential use of the associated gas is to make it into CNG onsite and for the CNG to then be shipped ashore for a variety of applications. Piping ashore may be an option if appropriate localised customers are found.

Thus assessed in isolation, a discovery such as Cutter-1 is unlikely to materially improve

Canterbury's or the South Island's natural gas markets. However, any successful discovery is likely to improve the prospectivity of the Canterbury Basin, eventually leading to more successful discoveries. It is the aggregate effect of such discoveries that may transform the energy supply picture and energy infrastructure of the Canterbury region, and of the South Island. In particular, the Barque-1 field and in the same permit area east of Cutter-1 has been identified as a gas and condensate prospect.

A key aspect of energy security is energy diversity. The availability of natural gas would add to the (long term) energy security of the region.

Case Study 3: Coal Bed Methane

New Zealand has the beginnings of a coal bed methane industry where suitable coal resources are available and cost competitive with similar and potentially substitutable fuels such as traditional natural gas and LPG. Manhire [31] recently presented the case for the production of methane from some coalfields in Otago and Southland. Potential uses for the gas include small-scale power generation, in increments of around 5 MW, and direct use as CNG in competition with LPG and diesel (for transport).

While the analysis presented implies that potential production is small at less than 300 TJ per year, and that the gas can be (cost) competitive if used within around 100km of the source, larger scale production and suitable applications could mean that gas from such sources may eventually be available to Canterbury consumers.

Case Study 4: Hurunui Irrigation And Power Project

In addition to Meridian Energy's abandoned Project Aqua proposal (280 MW), the region undoubtedly holds the potential for further hydro development subject to economic, environmental, social and recreational acceptability, amongst other considerations. Along with new wind farms, such developments may be able to obtain carbon credits, in a similar way to

the landfill methane case described above.

Most potential development schemes are likely to be smaller scale than historically with non-electricity aspects such as irrigation adding to the ultimate economics, in addition to the protection or enhancement of recreational and environmental values. Locational benefits are also likely to figure highly with some developments aiming to substantially bypass the grid in the style of distributed generation, in effect augmenting the grid or deferring its expansion.

The Hurunui Irrigation and Power Project is an example of the (energy) potential that remains in the region.

The Hurunui Irrigation and Power Trust [32] are promoting a development scheme on the Waipara and Hurunui Rivers. While most of the scheme involves the development of irrigation, a part of the scheme includes a dam and hydroelectric station on the Hurunui River.

Overall, the whole scheme is planned to irrigate an area of around 510 square kilometres and generate more than enough power for consumption in the MainPower supply area,

with more generation potential in the higher demand winter months than in the summer months.

With an estimated capital cost of around \$550 million, neither the hydro proposal nor the overall scheme is “small” [40]. Annual electricity revenues are estimated at around \$50 million and irrigation revenues at around \$90 million, with substantial “downstream” economic benefits.

While investigations have been ongoing since 1999, more research needs to be undertaken and consultations concerning non-irrigation and non-hydro issues such as environmental, recreational and lwi issues are yet to be resolved.

This proposal illustrates the energy potential that is still available within the Canterbury region and the spin-off benefits that might accrue. The slow progression of the proposal and the cancellation of Meridian Energy's Project Aqua do, however, illustrate the hurdles that such schemes need to overcome in order to proceed.

8 ISSUES AND OPPORTUNITIES FOR FURTHER INVESTIGATION

On the basis of the work undertaken to date, it is clear that there are many unresolved opportunities requiring further thought and consideration before an agreed basis for improving energy delivery to the region can be established. Importantly there is a need to bring a wider stakeholder group together under the auspices of the Forum to provide for further regional collaboration and decision on the priorities for future action that meets the needs of all the regional stakeholders.

Traditional supply chain approaches results in a centralised, market-led delivery system moderated (constrained) by national objectives and regulatory frameworks. This current review of the Canterbury regional energy system has confirmed that, whilst this model provides a significant level of assurance of future supply, there are risks and vulnerabilities to the wider regional economy inherent in the business-as-usual model. This traditional centralised model supports economic growth through a market-led economy; with just-in-time energy supply investments and incremental additions to the infrastructure stock.

Reliance on this centralised approach translates to an acceptance of the status quo with limited opportunities to affect different outcomes at the regional level.

The alternative is a new approach that takes better account of regional opportunities, industry capacity and local needs. Such an approach requires a more proactive regional planning response focussed on creating opportunities and delivering an overall improved energy supply system.

The work undertaken in this first stage of analysis helped to better define the strategic objectives that might inform such a process and also identified a number of core issues for further investigation and analysis. In order to chart a way forward, the Forum group then aligned these regional issues and opportunities so as to better articulate a critical decision framework and the key interdependencies that

would ensure a more effective energy delivery system to the region as a whole. An important aspect was to develop a better understanding of the weakest links and critical risk factors likely to govern infrastructure investment.

This framework, as set out below, has identified key opportunities for further collaborative action to:

- maximise the potential for the region to achieve greater energy diversity thereby reducing current high levels of import dependency,
- address existing supply chain risks through better alignment of industry planning assumptions and,
- create a regional planning framework that radiates out from the established weakest link and defines the critical path for investment in alternative energy supply options.

The key focus areas identified were:

Regional Context

- 1 The Canterbury region has a higher than average dependency on major transmission and supply system security:
 - Southward energy transfer constraints on the DC
 - Lack of locally embedded economic generation options
 - Small local generators have potentially high market influence
 - Securing designated infrastructure corridors would help reduce future delivery risks.
- 2 There are emerging environmental issues that could impact future energy demand, profile/s and future energy supply opportunities
 - Water scarcity/competition
 - Air quality/fuel substitution choices
 - Lack of reticulated gas.
- 3 The region has resource potential to achieve greater energy diversity and less

import dependency, but their economic timing and delivery remain uncertain.

- The region is currently leading NZ in using distributed generation as part of the energy system
 - Future large scale generation or remote systems potential needs to be better articulated?
- 4 Growth in tourism, business services and export food processing may influence desired levels of energy security.
- Transport growth has made a large contribution to energy import dependency and emissions
 - Future growth trends could be aligned with alternative energy supply options – e.g. bio-fuels and hybrid vehicles.

Industry Context

- 5 Supply chain risk can be addressed by aligning industry planning assumptions;
- Common assumptions/guidelines for infrastructure planning and timeframes (e.g. adopting a common 10 year outlook)
 - Asset age risk may be able to be better accounted for in delivery planning
 - Non-aligned incentives and/or asymmetric risks need to be acknowledged
 - Focus on aligning the 10 to 15 year planning frameworks.
- 6 The current market response framework encourages shorter planning and investment cycles;
- Shifts reliability related risks to the consumer
 - Increases timing/delivery risks for investors
 - Reduces “windows of opportunity”
 - Planning lead times are difficult to determine.
- 7 Incremental investment is valid but should not compromise the opportunities for realising key strategic regional benefits;
- Incorporating a wider risk and vulnerabilities assessment
 - Understanding situations where investing too late is worse than too early
 - Adopting rules or guidelines vs commercial drivers.

Local Context

- 8 South Island Reserve Energy Options should examine further;
- Regional winter market reserves risks
 - Benefits of economies of scale vs distributed solutions
 - Low South Island thermal reserves – value of system diversity
 - The vulnerabilities from not having N-G-1 in Canterbury.
- 9 There are opportunities for more integrated energy supply developments;
- Irrigation/hydro developments
 - Waste to energy projects (with carbon credits)
 - Regional distributed generation is leading NZ market – identify growth drivers
 - Smart meters – moving to demand-price elasticity, not just network system load management
 - Fuel substitutions – clean heating (biomass and solar) and transport (gas and biofuel blends).
- 10 The Region has some potential longer term strategic energy assets;
- On and Offshore gas prospects at 10 years+
 - Wind power (perhaps remote area systems?)
 - What other industries could thrive in Canterbury?

The focus areas described above all have implications that directly affect local and national planning for a reliable, affordable and sustainable energy supply for the region. Further analysis is required to enable alternatives to be rigorously compared and benchmarked against the counterfactual position of continued reliance on the status quo.

This will require that realistic future regional supply scenarios are developed, including the alternative options identified, in order that future development opportunities are aligned with these prospects.

The Forum Group has concluded that further

work could be undertaken with the following objectives;

- Establish clearer security of supply standards for both energy and transmission. Report and communicate South Island reserve margins as input to future industry planning.
- Determine regional adequacy requirements as inputs in support of regional planning submissions on proposed future transmission and generation investment – establishing a regional critical path analysis for key infrastructure and new energy investment options.
- Examine in more detail the potential for DG/RAPS type investment within the region.
- Undertake more in-depth assessments of

novel applications to meet future energy supply requirements, in particular the future role of smart metering systems and local fuel substitutes.

Finally, it is suggested that these work streams be combined into a Regional Statement of Opportunities (RSOO) in order to communicate to a wider stakeholder group the range of possibilities available to the region.

It is intended that the RSOO be used to develop a framework for examining different options (and the tradeoffs linked to critical path decisions) so as to facilitate a robust regional response plan in support of future regional development initiatives and community aspirations for a secure energy supply.

9 CONCLUSIONS

The analysis contained in this report shows that the Canterbury regional energy system can be best characterised by its increasing reliance on electricity for consumer energy and strong dependence on transport fuels for much of its economic activity.

The region appears more vulnerable to disruptions to its electricity supply than to the other non-grid energy resources, due to reasonably adequate storage for LPG and transport fuels and the relative ease at which non-grid resources can be reasonably re-supplied by road transport from neighbouring provinces.

In respect of the wider regional energy system, the critical vulnerabilities facing users and the region as a whole are exposure to price shocks from supply disruption and/or increasing capacity constraints.

The analysis undertaken to date has also shown that there is a considerable opportunity for a more integrated energy supply as well as potential for the development of substantial longer-term strategic energy assets. Canterbury is unlikely to realise these alternative regional opportunities under the current centralised energy supply model that relies on a market-led economy; just-in-time energy supply investments and incremental additions to the infrastructure stock.

Too often, the objective function of economic efficiency (central to current the current centralised planning model) does not adequately account for the desire for regional economic development or the needs or concerns of local communities.

However, exploitation of these resources and giving closer attention to local needs have the potential to deliver economic benefits and improved energy security to the region. From the analysis done to date, it is clear that within the Canterbury region, the extent of these opportunities remain largely undefined and their potential contributions uncertain.

The key to any strategy that seeks to encourage local supply is diversity of both location

and mix of generation. The benefits of diversity enable economic development while also contributing to resolving the capacity and security issues being driven by demand growth and requirements for improved supply reliability.

A lack of coordination at the regional level, incumbent players continuing with conventional business modes, and changing demographics and load patterns all combine to leave the Canterbury region vulnerable to sub optimal outcomes and, thus, a failure to meet consumer expectations for a reliable and affordable energy supply.

The way forward will require a different approach. Section 8 sets out a decision framework for the region to better articulate these critical energy issues and decide on the tradeoffs needed to bring together a portfolio of opportunities deserving of more analysis and investigation. It is suggested that a critical path approach be adopted and that further work be undertaken by the Forum to bring together a Regional Statement of Opportunities as a basis for future regional planning.

A major input to such an analysis is developing a reasonably accurate forecast of future demand and regional requirements. This study has identified a number of areas where the current approach to demand forecasting could be improved and a regional cost-benefit model promoted. Currently energy planning occurs both at the national and the regional level. There is a strong case for these two separate planning processes to be brought together into a truly integrated planning approach.

This, of course, is the intent in the subsequent stages of this project. Industry leadership is essential to this process, and to act as a catalyst for change. There is much more work yet to be done to quantify and assess the different substitution options and supply scenarios identified by this report, but without industry involvement such effort is unlikely to move beyond aspiration.

By adopting a proactive stance and actively

encouraging engagement and input from all stakeholders in the development of a Regional Statement of Opportunities, CRESO can contribute significantly towards creating a long-term strategic horizon for regional energy planning and achieving community understanding of the critical issues facing the region.

Canterbury has the opportunity to bring together a future road map that will not only chart the forward for the region but also help

to identify gaps in the national energy policy frameworks affecting regional economic development and community needs. Success in this endeavour will ultimately lead to a regional template for collaboration and planning that will be deployable to other regions to better align regional requirements and priorities through the country within national energy policy and strategy frameworks.

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APPENDIX 1: EXTRACT OF THE COMMON LANGUAGE

	EC	TRANSPower	MERIDIAN	ORION
DOMAIN	Regulation	Transmission	Generation / Retail	Distribution / sub-transmission
CRITERIA				
Investment Horizon	20yrs (SOO)	10yrs	20yrs	10yrs but focused on immediate 3-5yr horizon
Pricing Regime	Efficient Pricing	Postage Stamp Tariff	Generator = Wholesale Spot Price Retailer = unit charges and line rental	Line Charges
Options Analysis	Grid Investment Test	Business Decision (ROI=?)	Business Decision (ROI=?)	Business Decision (ROI=?)
VOLL	\$20/kWh or \$20000/MWh	\$20/kWh or \$20000/MWh		\$13.72/kWh + \$6 /kW VOI
Location Factors & Constraints	N/a	Systems Studies & Simulations	System Studies & Nodal Risk Analysis	Load Growth

Table 11: Common Language Extract

The extract above provides an indication of the variation in some of the key criteria used by the regional stakeholders.

In order to provide a robust analysis of regional priorities and infrastructure investment opportunities in a Regional Statement of Opportunities, it will be necessary to ensure some degree of standardisation in the data

provided for analysis.

In Stage 1, the scope only allowed the Study Team to collate the information for the Common Language from publicly available documents. No analysis has been undertaken to assess or validate the Key Criteria. This is likely to be a task for Stage 2.

APPENDIX 2: POTENTIAL NEW GENERATION IN SOUTH ISLAND BY SCENARIO AND COMMISSIONING DATES

The following table identifies various generation opportunities in the South Island and estimates when they would be commissioned under the future generation scenarios as defined by the Electricity Commission in their Statement of Opportunities. An example is:

Gas Thermal: Underlying the Gas Thermal scenario is the assumption that timely and

extensive exploration for gas means that the bulk of new generation is gas-fired. New plant is predominantly commissioned near load centres or major gas distribution areas.

For further scenario definitions and information refer to the Electricity Commission's Statement of Opportunities.

Plant	Location	Type	MW	GWh (pa)	Commissioning Dates by Scenario				
					Gas Thermal	Coal Thermal	Large Scale Hydro	Renewables	Low Demand
Banks Peninsula	Canterbury	Wind	100	395			2024		
Canterbury Wind Farm	Canterbury	Wind	50	150				2009	
Clarence to Waiau	Canterbury	Hydro	70	300			2017	2017	
Coal in Chch	Canterbury	Coal	50	130	2009				
Dobson	West Coast	Hydro	60	270	2017		2012		
Hawea 1	Otago-Southland	Hydro	30	171	2019				
Hawea 2	Otago-Southland	Hydro	90	435			2015		
Hurunui Lowry Peaks	Canterbury	Hydro	36	160	2015		2015	2015	2015
Invercargill Wind	Otago-Southland	Wind	180	550			2008	2013	2013
Lower Grey River	West Coast	Hydro	210	920			2018	2013	
Lower Waiau	Canterbury	Hydro	50	220			2020	2020	
Lower Waitaki 1	South Canterbury	Hydro	260	1500			2009	2022	
Lower Waitaki 2	South Canterbury	Hydro	260	1500			2014		
Manapouri 1	Otago-Southland	Hydro	25	158	2004	2004	2004	2004	2004
Manapouri 2	Otago-Southland	Hydro	16	105	2005	2005	2005	2005	2005
Mid Waiau	Otago-Southland	Hydro	60	270				2024	
Nevis River	Otago-Southland	Hydro	45	197	2015			2021	2021
Pahau	Canterbury	Hydro	43	190			2015		

Pukaki Canal Intake	South Canterbury	Hydro	44	120	2020	2020	2020
Rough River	West Coast	Hydro	11	49	2024	2019	
Seddon Wind Farm	Nelson-Marlborough	Wind	80	250	2021	2021	2021
Southland Lignite 1	Southland	Coal	380	2650		2012	
Southland Lignite 2	Southland	Coal	380	2650		2021	
Stockton Coal	West Coast	Coal	150	985		2009	2009
Taieri Hydro	Otago-Southland	Hydro	40	175	2015		2020
Taieri Mouth Wind Farm	Otago-Southland	Wind	200	615	2024	2014	
Te Anau Gates	Otago-Southland	Hydro	65	350	2014	2019	
Upper Grey River	West Coast	Hydro	35	153	2023	2018	
Upper Waiau	Canterbury	Hydro	56	240		2023	
Wairau	Nelson-Marlborough	Hydro	70	415	2014		2014
Total Potential New Generation by Scenario (MW)					1945	1493	686

Table 12: EC SOO South Island Generation Scenarios [11]

This Table highlights potential generation opportunities in the South Island under different scenarios modelled by the Electricity Commission in its 2005 Statement of Opportunities. These projects can only be considered as 'potential' rather than 'probable'. Stage 2 will attempt to establish the likelihood of these projects by examining the factors that would support their viability (e.g. nodal prices, hedge prices etc) and the trade-offs that may be possible at a regional level to facilitate their development.

APPENDIX 3: POTENTIAL GENERATION OPPORTUNITIES IN CANTERBURY

	Coal	Hydro	Wind	Total	
Gas Thermal Scenario	200	317		517	MW
	1115	2614		2744	GWh pa
Coal Thermal Scenario	910	41	951		MW
	6285	263	6548		GWh pa
Large Scale Hydro Scenario	1485	460	1945		MW
	7415	1415	8830		GWh pa
Renewables Scenario		983	510	1493	MW
		4742	1565	6307	GWh pa
Low Demand Scenario	150	276	260	686	MW
	985	1330	800	3115	GWh pa

Table 13: Generation Opportunities in Canterbury [11]

The Table above summarises the potential generation capacity within the Canterbury region under the various EC SOO Scenarios

while the table below provides an indication of the costs of implementing the projects modelled for each of the scenarios.

	Capital Cost (\$m)		Operating Costs (\$m)		Total (\$m)
Scenario	Generation	Transmission	Variable	Fixed	
Gas Thermal	\$2,457	\$587	\$11,106	\$414	\$14,564
Coal Thermal	\$3,009	\$884	\$11,979	\$569	\$16,531
LS Hydro	\$5,399	\$686	\$8,052	\$771	\$14,908
Renewables	\$4,275	\$693	\$8,326	\$612	\$13,907

Table 14: Implementation Costs [11]

Peer review noted that Table 14 could be improved by presenting fixed and variable operating costs in c/kWh terms. A number of assumptions would need to be made in order

to do this but with assumptions stated the resulting information would be more meaningful than is currently presented.

